THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

ART. XLIII.—*Experiments on the nature of the force involved in Crookes' Radiometer;* by Prof. O. N. ROOD, of Columbia College.

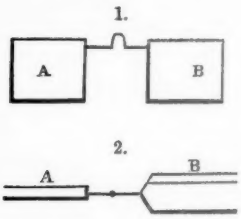
IT is impossible for a physicist to regard the little instrument devised by Mr. Crookes with other than a feeling of unusual interest, based partly on the performance of the apparatus itself, and partly on possible applications which immediately suggest themselves. The explanation of these curious phenomena offered by Ronalds, and afterward more in detail by Stoney,* together with the confirmatory experiment of Schuster, led me to devise two new methods for still farther testing the theory thus advanced, and to make at the same time an examination of the phenomena when the suspended discs were under the ordinary atmospheric pressure.

The explanation offered by Stoney is based on the mechanical theory of gases, and reaches the final result that a reaction takes place between the blackened sides of the movable vanes and the glass envelope, so that there is a tendency for them to recede from each other. I first arranged an experiment so that I could at will destroy the possibility of this reaction taking place, without interfering with the other necessary conditions.

Description of the apparatus.—Two discs of thin aluminium foil, A and B, fig. 1, the same in size, were prepared, and

* On Crookes' Radiometer; G. Johnstone Stoney, Phil. Mag., March and April, 1876.

blackened, each on one side, with lampblack to which a minute portion of spirit varnish had been added. Each disc was folded so as to be double, the two leaves not being in contact. Disc B carried in front of it a plate of mica equal in size with itself, and distant from it about 5 mm. The system was arranged so as to be capable of suspension by a single fiber of silk, and was provided with a small directing magnet. Fig. 2 gives a view of the arrangement from above.



The discs thus arranged were enclosed in a clear glass flask, which was exhausted to a pressure of ·25 of a millimeter and sealed up.

The flask with its contents was then placed on a graduated circle and centered. The deviations of the disc were observed by a compound microscope of low power, which was capable of independent rotation about the axis of the circle. It was provided with an index with which tenths of degrees could readily be estimated, the circle itself being divided into half degrees. The small magnet connected with the discs was rendered nearly astatic by an external magnet: it consumed thirty-two seconds in making a single oscillation.

Experiments.—The light of a luminous gas-flame at a distance of twelve inches was allowed to fall on the blackened disc not provided with a plate of mica, its companion being protected by a triple screen of sheet brass from the action of the flame. Under these circumstances the exposed disc moved away from the light: after it had come to rest ten readings were made; below is the result obtained by two such experiments:

3°·06
3°·40

3°·23 mean deviation away from light.

Next, the vane provided with the mica shield was exposed, the other being screened. After a slight agitation it came to rest, and ten readings were made as before; the results of two experiments are given below:

0°·26 away from light.
0°·06 toward the light.

0°·10 mean.

It will be seen that the interposition of the mica plate attached to the vane actually did prevent any reaction from taking place between the disc and the walls of the flask, so that prac-

tically the disc remained immovable. In the next experiment the brass screen was entirely removed, and the light allowed to fall on both discs simultaneously, a plate of mica, identical in substance with that attached to the vane, being placed outside of the flask and opposite the unprotected vane, so that both vanes received the same amount of radiation, the only difference being that one of them was deprived of its direct communication with the walls of the flask. Under these circumstances the disc without the attached mica screen moved instantly away from the light, as was shown by two careful experiments:

$$\left.\begin{matrix} 2°{\cdot}42 \\ 2°{\cdot}34 \end{matrix}\right\} \text{away from light.}$$

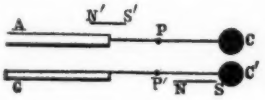
$$2°{\cdot}38 \text{ mean.}$$

These results I regard as confirmatory of the theory advanced by Stoney, and as fatal to the idea that the motion is directly dependent on the impact of light or heat, for both discs received the same amount of heat and light.

According to the theory just referred to in these experiments repulsion took place between the blackened disc and the mica attached to it, but being firmly fastened together, no motion of either could result. Assuming this repulsion to exist I devised an apparatus for making it evident and for measuring its amount.

Description of Apparatus.—A disc of aluminium, folded double and blackened on one side, was provided with a small magnet, and suspended by a single fiber of silk in the interior of a glass flask. In front of this was similarly suspended a disc of glass such as is used for covering microscopic objects; it also was provided with a small magnet and both discs were properly counterpoised. These discs were each seventeen millimeters long, and fourteen millimeters high: the weight of each was 0·3 gram, and the minute magnets attached to them were of nearly equal strength. The distance of the points of suspension apart was five millimeters. Figure 3 furnishes a view of the system seen from above.

3.



A is the aluminium disc, G that of glass, P and P′ are the points of suspension, C and C′ the counterpoises, which being on different levels readily passed each other; and N S and N′ S′ are the controlling magnets. The exhaustion of the flask was carried to 0·24 of a millimeter.

Experiments.—It will be observed that the magnets were so arranged as to tend to cause the discs to touch each other, but

in ordinary daylight, or even in feeble daylight, the repulsion was so strong as to cause the discs to assume a parallel position, or even to diverge several degrees. They could not be brought into contact even by covering the flask with white writing paper, but paper thickly painted with lamp black always caused contact in a few minutes. When this apparatus was placed in a darkened room, and suddenly exposed to a luminous gas flame sixteen inches distant, the discs instantly diverged, right and left, with sensibly equal velocities, and after some slight oscillation came to rest. Below are given the final deviations in two trials; five readings being taken in each experiment.

Aluminium.	Glass.
12°·97	8°·36
12°·55	8°·43

Taking the mean of the two experiments, and calling the deviation of the aluminium 100, that of the glass is 65·7. The results just given are sufficiently concordant, and could have been obtained repeatedly without greater variation; still, owing to slight defects of workmanship in the apparatus, I do not lay any great stress on them, further than to prove that both discs are deflected, and that the deflection of the glass disc toward the light is somewhat less than that of the aluminium away from it. In another experiment with a similar apparatus, it was found that if the deviation of the aluminium was taken as 100, that of the glass was 74·8.

The result of this experiment, is, as it seems to me, absolutely fatal to any theory which assumes that the repulsion in a Crookes' radiometer is due to the direct impact of heat or light, and I think also it cannot well be explained by assuming the existence of ordinary convection currents.

Experiments under the full pressure of the atmosphere.—Being anxious to make some experiments under the ordinary atmospheric pressure, I arranged a blackened disc of aluminium foil, composed of two laminæ, counterpoised, provided with a small magnet, and suspended by a single fiber of silk in a glass flask. The time of oscillation of the system I could not determine, owing to friction against the air, but judge that it was between thirty and forty seconds. This apparatus was centered on the graduated circle, and the disc observed as before with a compound microscope. It was soon ascertained that the observer exercised, apparently, an attraction on the suspended disc, even when seated nearly in its prolongation; it followed and pointed toward the observer sitting at a distance of little less than a meter with considerable promptitude, being thus deflected from

its true position as much as 20°. The cause of this phenomenon I take to be, that the dark heat from the face of the observer warms mainly that part of the flask directly opposite him; this causes a feeble ascending current of air in that region, and this again a horizontal current toward the heated wall, the latter current acting on the disc precisely as the wind does on a weather-cock. The deflection from this cause was pretty constant, and did not prevent qualitative observations from being made, though in the more important cases I avoided it altogether by quickly taking the reading with the aid of a screen, and then retiring for some minutes to the other side of the room before taking a second reading.

Experiment with gas flame and a solution of alum.—The light of a luminous gas flame at a distance of a foot, after passing through a saturated solution of alum 41 mm. thick, was allowed to act on the blackened side of the disc, and forty readings were taken at intervals of about twenty seconds. A repulsion from the light was produced; below is given the deviation indicated by the mean of each successive set of ten readings.

0°·6 4°·01 3°·01 4°·1.

The alum solution was now removed, when the disc began to move rapidly toward the light, and after twenty readings, had reached a final deviation of 28°·7 toward the light. Here it remained stationary with small fluctuations. Being convinced that the deviation of 28°·7 was due solely to the heating of the glass by the naked gas-flame, causing thus a current to set toward it, and drawing the disc in that direction after the manner of a weather-cock, I moistened the side of the glass next to the gas flame with water at the temperature of the room, by the aid of a small camels' hair brush. For a second or two, no effect was produced; then a large repulsion ensued rather forcibly, the disc being driven away from the light, a deflection of as much as 180° being obtained, which tended of course to confirm the idea I entertained.

While making the observations just mentioned, I was seated near the apparatus: they were now repeated, at intervals of two minutes, the alum solution being employed, and the observer removing each time to a considerable distance from the apparatus. Below are the results of three experiments, consisting each of only two determinations of the zero point, and two of the deflection: 16°, 15°·4, 15°·8 away from light.

These and other equally constant results established beyond a doubt the fact that repulsion takes places when the radiations are such as not sensibly to heat the walls of the flask, and it is seen that with these conditions, the disc under the full atmospheric pressure *imitates the behavior of one suspended in a vacuum.*

I conceive the cause of these phenomena to be as follows: the radiations falling on the blackened disc heat it, and generate thus an ascending current of air, which sweeps upward along the surface of the disc, *gathering volume* as it travels from the lower to the upper edge, and tending thus to drive the disc away from the light. The cross section of the ascending current of heated air would then, roughly speaking, assume a shape like a V. To test this idea, I arranged the disc so that its upper edge should be bent away from the light, like an A, so as to give room to the ascending current of air; now, instead of hanging with its walls vertical, they were deflected as much as 15°. This deflection was so small as not materially to diminish the projection of the surface exposed to the light, but it was found practically to destroy the repulsion. Four experiments were made, each consisting of four readings of the zero point, and as many of the position of the disc after exposure, the observer removing each time to a distance from the apparatus; the results are given below.

Toward the light.	Away from light.
0°·2	2°·4, 0°·1, 1°·1.

This gives as the mean result a repulsion of 0°·8, and shows that the phenomenon differs essentially from that involved in a Crookes' radiometer.

With this same apparatus, the disc being still bent out of its vertical position, I now repeated the fundamental experiment of exposing the apparatus to the action of a naked gas flame under atmospheric pressure; the results of these trials are given below.

(1.) The disc remained stationary a moment, and then moved toward the light.

(2.) Same result.

(3.) Moved a few degrees away from the light, afterward 40° or 50° toward it.

(4.) 8° away from light, then a large number of degrees toward it.

(5.) Small deviation toward light, small deviation away from it, large deviation toward it.

(6.) Disc stationary, 5° away, 50° or 60° toward light.

(7.) 5° or 6° toward light, stationary, large deviation toward light.

The blackened disc was now arranged so as to hang vertically, and the experiment repeated, all the other conditions remaining unaltered.

(1.) Repelled 20°; then began to move slowly toward flame; on extinguishing the latter, a large sudden motion in same direction.

(2.) Repulsion of 40° or 50°; return to zero point; remained nearly stationary at zero point; sudden and large deflection toward flame, when it was extinguished.

(3.) Same as last.

(4.) Repulsion of about 5°, attraction 60°.

These experiments show that, as a general thing, the first effect is repulsion, the second attraction. They are, I think, sufficiently explained by assuming the existence of a vertical current, on the heated surface of the disc, and a horizontal current directed toward the heated side of the flask; these act antagonistically, and when the disc is vertical, often balance each other more or less perfectly for quite an interval. On extinguishing the flame, the vertical current is greatly weakened, while the horizontal one is not much affected, hence the violent deflection toward the heated side of the flask.

New York, June 27th, 1876.

ART. XLIV.—*Experiments on the Sympathetic Resonance of Tuning Forks;* by ROBERT SPICE.

IT is well known that a pair of forks having a vibration number of 256, (Kœnig's Ut^3 forks) show the phenomenon of sympathetic resonance at distances apart varying from three to six feet. Beyond six feet, special and delicate means have to be employed to exhibit their resonance.

It is also well known that a pair of forks having a vibration number of 512, (Ut^4 forks) exhibit the phenomenon with similar intensity at far greater distances. The accepted solution of this difference of deportment is, that as in the latter case double the number of impulses are delivered in a second, consequently double the energy is conveyed to the distant fork.

If this explanation be sufficient, the following result should follow: Forces radiating from a center obey the law of inverse squares; hence, if the amount of motion (or force?) received by an Ut^3 fork at a distance of six feet from its excited fellow be represented by n; then (assuming an Ut^4 fork to have double the energy of an Ut^3 fork,) clearly, the amount of motion received by an Ut^4 fork at a distance of twelve feet from its excited fellow, should be represented by $\frac{n}{2}$. But so far is this from being the case, that the intensity instead of being one-half (as calculated) is more than double. In fact, at twenty feet the

intensity of resonance of Ut^4 forks is undoubtedly greater than the intensity of Ut^3 forks at six feet.

A pair of forks were cast in a kind of bell-metal, and tuned to Ut^3. On Kœnig's boxes the resonance was quite obvious at twenty feet, and at forty feet the responding fork drove a cork ball 8^{mm} diameter a distance of 10^{mm}! This result was greater than that obtained with the steel Ut^4 forks of Kœnig. In view of these facts, it seemed to me that a different explanation was required to clear up the difficulty: and, after a careful experimental examination of the question, I offer the following hypothesis:

The intensity of sympathetic resonance of forks on their cases increases with the angular deviation or motion of the prongs.

The question of number of vibrations per second has its proper value, but this value is small compared with the element above stated.

I proceed to explain this hypothesis. Suppose that we wish to set a pendulum in motion, but are required to fulfill the two following conditions: First. We are obliged to hold the cord of the pendulum (point of suspension) in our hand, and this hand is also to be the motive power, to start and keep the pendulum in motion. Second. We are only to be allowed a lateral movement of the hand of one inch each way, making in all two inches.

Now the amount of motion or amplitude of a pendulum is estimated by the angle the cord or rod makes with the vertical; and clearly, if the point of suspension moves laterally, it thereby creates an angle. If, further, the point of suspension has a reciprocal motion in accord with the possible time of the pendulum, then, by the principle of the summation of impulses, the motion of the entire pendulum will be gradually augmented up to a limit determined by well-known mechanical theorems. But if amplitude is expressed by angular magnitude, then, if the initial angle be increased, the total motion must be acquired in less time and be greater. From which it follows that, retaining the conditions above stated, if we operated on a pendulum ten inches long, we should set it in its maximum motion in less time and with less expenditure of force than if we operated on a pendulum fifty inches long. Experience confirms this.

A fork vibrates after the manner of a pendulum, and may be looked upon as an inverted pendulum; but whereas, the *length* of a pendulum determines its vibrating period, the *length* and *thickness* together determine the period of a fork. Again: the period of a fork varies *directly* as the *thickness*, but inversely as the *square of the length;* hence a small alteration of length will make a large difference in its period; or, conversely, a

large alteration of period does not imply a large difference in length.

From measurements made with an electro-chemical registering apparatus, which I designed for this and similar investigations, I find that when a fork of the usual dimensions (between Ut^3 and Ut^4) is in vibration, its stem or handle alternately rises and falls in accord with the period of the fork, through a distance of about $\frac{1}{8}\frac{1}{0}$ inch. When a fork on its case is influenced by a distant fork, the case gives the stem this up and down motion, which is conveyed to the prongs and sets them in vibration after the manner of the hand starting a pendulum as specified above.

This motion of $\frac{1}{8}\frac{1}{0}$ inch may be looked upon as a constant, and corresponds to the two-inch motion of the hand in the illustration. If we decrease the length of the fork without altering the constant, we thereby allow of a greater initial angle; the result of which we have already noted—it is the same as shortening the pendulum cord. This much understood, we are in a position to explain the deportment of the bell-metal forks cited. The velocity of sound in bell-metal is much less than in steel, hence, retaining similar thicknesses in both cases, an Ut^3 fork in bell-metal would be shorter than an Ut^3 fork in steel; the ratio of the length of the steel to that of the bell-metal ranging as 90 : 75. Therefore, though we retain the vibration-number, we gain advantage from the shortness of the fork, and hence from the increase of angular motion of the prongs.

It was suggested to me that possibly bell-metal had the property of accepting motion more readily than steel. To test this point I made a pair of Ut^3 steel forks, shorter than Kœnig's, and of course thinner, in order to retain the vibration-number. These forks behaved just like the bell-metal forks. Further, I made a pair of Ut^4 forks as long as Kœnig's Ut^3 forks, and of course thicker. These behaved like Kœnig's Ut^3 forks. Finally, taking a Kœnig Ut^3 fork on its case, and one of the short Ut^3 forks also on its case; on placing them twenty feet apart, it was found that, on exciting Kœnig's fork, my short fork responded well, whereas on exciting the short fork Kœnig's did not respond at all.

230 Bridge st., Brooklyn, July, 1876.

ART. XLV.—*Types of Orographic Structure;* by Major J. W. POWELL.

[The following pages on "Types of Orographic Structure," are cited from Major Powell's Report on the "Geology of the Uinta Mountains." They are preceded in the volume by a brief topographical account of the region between the Sierra Nevada and the Front Range of the Rocky Mountains, and having for its northern boundary, as at present understood, the North Platte and its proper upper continuation, the Sweetwater River. This area is divided into three provinces, namely—passing from east to west,—the Park Province, the Plateau Province and the Basin Province. The first is described as including the great parks of Southern Wyoming, Colorado and Northern New Mexico, and comprises many ranges of mountains which are "characterized by a great development of metamorphic crystalline schists, mostly Archæan in age, with patches and structural basins of marine and lacustrine sediments of later time, and a complicated series of volcanic formations.

The Plateau Province is that directly drained by the Colorado and its tributaries, through which the streams generally run, not in wide valleys, but in cañons; the vast area is strictly a plateau region embracing many table-shaped elevations bounded by cañon and cliff escarpments, and differing in its succession of sedimentary strata from others in North America, and also in its displacements or uplifts; moreover, Cenozoic and Mesozoic rocks prevail, though some of the important plateaus are of Carboniferous beds, and in places the subjacent rocks even down to the Archæan are exposed to view in consequence of erosion.

The Basin Range system includes the Great Salt Lake region, and other valleys and ridges extending through Western Utah, Nevada, Southeastern California and perhaps across the Colorado in Western Arizona; and embraces Paleozoic beds as well as metamorphic schists, along with eruptive beds, some of which are the principal component parts of the ranges.]

IT seems convenient to give a general account of the types of orographic structure in the Colorado region before characterizing each province by its special type.

In this discussion I wish to use certain terms with a restricted or relative meaning; i. e., in treating of anticlinal and synclinal flexures I shall speak of those portions of the sedimentary beds which are adjacent to the anticlinal axes as having been upheaved, and those portions near their synclinal axes as having subsided. Again, in blocks which are bounded by faults and tilted, I shall speak of such portions as are at a higher level as having been uplifted, and portions occupying a lower level as thrown. In such cases I do not wish to commit myself to any

theory of upheaval or collapse in the change of the relation of the several parts of these beds to the center of the earth.

In treating of the structure of the mountains under consideration it is necessary to distinguish two great classes, viz: those composed of sedimentary strata, altered or unaltered, and those composed of extravasated material.

Mountains composed of Sedimentary Strata.

I. *Appalachian Structure.*

The structure of the Appalachian Mountains, with closely appressed folds and axial planes tipped back from the sea, the modifications of these folds by faults, and the primary and concomitant forms of the mountains, have been clearly explained by the Messrs. Rogers and later writers, and have formed the basis of many discussions concerning geological dynamics. This Appalachian structure needs no further mention here, as it is a type of structure which so far has not been found in the region described above, and should it be found hereafter it will simply be an exceptional type to those known to prevail.

II. *Simple Anticlinal Structure.*

Mountains or short ranges carved from simple anticlinals are sometimes found, though this type of structure is not a prevailing one. Usually in such a case the great mountain mass lies in the central zone of the uplift. The fold is, of course, always found truncated by erosion, and the mountains represent but the difference between the amount of upheaval and the amount of such erosion. When not complicated by other types of structure the strata dip on all sides from the center of upheaval, gently or more abruptly, but the sides of the folds are never closely appressed. Such mountains in primary form are gently rounded in general outline, modified by the erosion of the streams running down their sides. Sometimes such mountains are severed by rivers running longitudinally, transversely or obliquely through them; the rivers themselves having their sources in regions far away and passing through the mountains in their courses to the sea. In Northeastern Colorado a short distance above the junction of the Snake River with the Yampa, stands Junction Mountain, which serves as a fine illustration of this type of structure. The mountain is divided into two unequal parts by a cañon, through which the Yampa River runs. The axis of the mountain has a north and south direction.

Figure 1 is a section through this mountain, in a north and south direction, along the axis of upheaval. Figure 2 is a section through it in a transverse direction.

CONCOMITANT FORMS.

1. *Monoclinal Ridges on the Flanks.*—Under conditions which are so well known as to need no further explanation here, monoclinal ridges or hogbacks are formed on the flanks of such up-

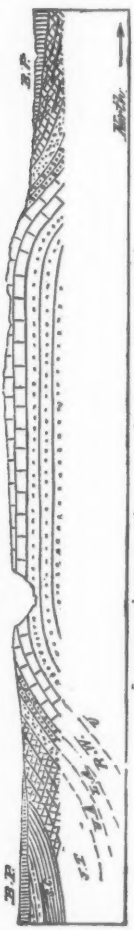


FIG. 1.—Section through Junction Mountain, north and south.

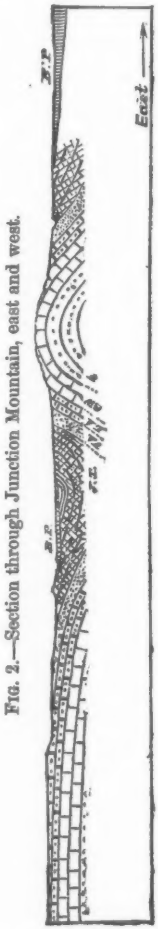


FIG. 2.—Section through Junction Mountain, east and west.

B. P., Brown's Park; S. C., Sulphur Creek; J. T., Jura Trias; U. A., Upper Aubrey; L. A., Lower Aubrey; R. W., Red Wall; U., Uinta.

heavals, and sometimes such monoclinal ridges are of such magnitude as to be dignified with the name of mountains. Where two or more series of indurated, inclined beds are separated by extensive series of softer material, two or more monoclinal ridges may be formed.

2. *Monoclinal Ridges only.*—Sometimes we find that an anticlinal upheaval has been eroded in *intaglio*, so that there is no great central mountain mass, but the axis of upheaval is the site of a valley or low plain, but the monoclinal ridges on the flanks remain.

3. *Inclined Plateaus.*—Where the anticlinal upheaval has a great amplitude, as compared with the vertical uplift, the beds incline but slightly. Under such conditions inclined plateaus or mesas are found instead of monoclinal ridges, usually having steep escarpments facing the axis of the flexure.

III. *Uinta Structure.*

In the Uinta Mountains we have a great range carved from an anticlinal upheaval, the axis of which has an easterly and westerly trend, and is more than one hundred and fifty miles in length. It terminates abruptly against the Wasatch Mountains on the west and is cut off by the short, abrupt anticlinal of Junction Mountain on the east, the latter having its axis in a north and south direction. There are several important facts observed in the study of this great flexure. Its axis has been lifted above the level of the sea about thirty thousand feet, and above the level of the adjacent country about twenty-five thousand feet. From flank to flank the flexure is about fifty miles, but varies much in width. We find on either flank, many miles from the axis, a line of maximum flexure, which line presents a subparallelism with the meandering axis. These lines have the effect of two monoclinal flexures in opposite directions, separated by the broad table, diversified by elevated valleys and peaks of which the great mass of the Uinta Mountains is composed. But the portion between these monoclinal flexures or lines of greatest flexure is itself gently flexed. In many places that which I have called the line of greatest flexure is indeed a fault, in one place on the north side of the Uinta Mountains having a throw of twenty thousand feet. On the south side the line of greatest flexure is very irregular, being complicated in some places by faults having uplifts opposed to the downthrow of the flexure. On either side the great displacement is partly by faulting, partly by flexing, and either flank is a zone of diverse displacement where the strata are faulted, flexed, twisted and contorted in many ways.

The character of these displacements in the Uinta Mountains is illustrated in Plates, 1, 2 and 3 of the Atlas, and in a subsequent chapter the subject will be more fully discussed.

The simplest topographic forms, produced by such displacements under conditions of erosion in general outline, are plateaus with gently rounded summits and abrupt shoulders on the flanks; but such general outline is often modified by the

corrasion due to antecedent or superimposed drainage; that is, by the corrasion of streams that head in remote regions and pass through these uplifts either longitudinally, transversely or obliquely, as in the case of Simple Anticlinals.*

There are other modifications which sometimes greatly obscure the general topographic outline due to consequent drainage, i. e., the local drainage which is due to the upheaval itself and which produces interesting

CONCOMITANT FORMS.

1. *Subsidiary Plateaus.*—Sometimes the streams which head near the axis of such an upheaval, as they meander to the flanks, excavate valleys and divide the great block, which is a plateau in general outline, into minor plateaus which are separated by intervening but elevated valleys. This is especially the case where the streams in their upper courses follow for some distance the strike of the beds before turning to cross the more or less abrupt lines of maximum flexure. Sometimes these streams run in deep gorges; in such cases the plateaus are bounded by cañons.

2. *Projecting Ridges.*—When these consequent streams starting near the axis of upheaval take a somewhat direct course across the strike, the general plateau is cut into a series of sharp, abrupt ridges having a trend at right angles to the strike or general axis of upheaval. Thus the points of the ridges face the plain below and are separated by deep gulches and cañons, and the observer on the plain below sees before him what appears to be a line of peaks separated by intervening gulches and valleys, and is apt to misunderstand the topographic character of the great mass which is before him.

3. *Axial Peaks.*—At some stages in the progress of erosion the channels of consequent drainage inosculate, and about their heads gorges are formed, with towering amphitheaters. In such cases an irregular line of crags and peaks will be found along the axis of upheaval. These I call axial peaks.

4. *Flanking Peaks.*—Sometimes we find a very hard bed or group of beds underlaid by more friable strata on a flank of the upheaval, which harder beds have been carried away by erosion from those portions of the upheaved mass nearer the axis. In such cases each projecting ridge is crowned with a true peak. I call these flanking peaks.

5. *Interrupted Monoclinal Ridges.*—On the flanks of these upheavals, but farther from the axis than the flanking peaks, monoclinal ridges are often found sometimes broken by gaps

* For an explanation of what is meant by antecedent and superimposed drainage, the reader is referred to the Report on the Exploration of the Colorado River and its Tributaries, page 160, *et seq.*

which are the channels of intermittent or permanent streams, and these ridges are very irregular and often interrupted. Where the downthrow is by simple flexure, a complete series is formed. Where it is partly by flexing and partly by faulting, some of the monoclinal ridges disappear. Where the faulting is on the side of the zone of maximum flexure nearest to the axis, the ridges of the upper beds appear; but where the faulting is on the side of the zone of maximum flexure farthest from the axis, the ridges of the lower beds appear; and where the displacement is chiefly or entirely by faulting, there are no monoclinal ridges.

IV.—*Kaibab Structure.*

In the region under discussion we often find the sedimentary beds broken into blocks by faults or their homologues, monoclinal flexures, and these blocks have been gently tilted in broad masses. I have discussed this subject somewhat at length in my Report on the Exploration of the Colorado River of the West and its Tributaries, published in 1875; and in fig. 3 I reproduce a section and bird's eye view of the plateaus north of the Grand Cañon, which was used in that volume. An examination of this will fully reveal the characteristics of what I have called the Kaibab structure. The grand topographic features which result from this structure are plateaus with broken edges where they are bounded by faults, flexed edges where they are bounded by monoclinal flexures, and with escarpments where they are bounded by cañons or lines of cliffs.

Concomitant Forms.

1. *Cliffs of Displacement.*—When a plateau is bounded on one side by a fault, the edge of the plateau is an escarpment often so abrupt as to present a more or less irregular line of cliffs.

2. *Slopes of Displacement.*—When the displacement is a flexure rather than a fold, the edge of the plateau is a broken slope. I have discussed these cliffs and slopes of displacement somewhat at length in the volume already quoted several times, page 182 *et seq.*

3. *Monoclinal Ridges on the Flanks.*—On the flanks of these monoclinal flexures, under proper conditions which have already been described, monoclinal ridges are formed.

4. *Monoclinal Ridges with Plateau carried away.*—As in simple anticlinal upheavals the central mass may be entirely carried away leaving but monoclinal ridges, in like manner in the Kaibab structure the principal plateau mass may be carried away leaving only the monoclinal ridges. This I have also discussed in the volume already quoted.

5. *Projecting Ridges.*—It is seldom, perhaps never, the case that the strata of one of these plateaus are left by the general

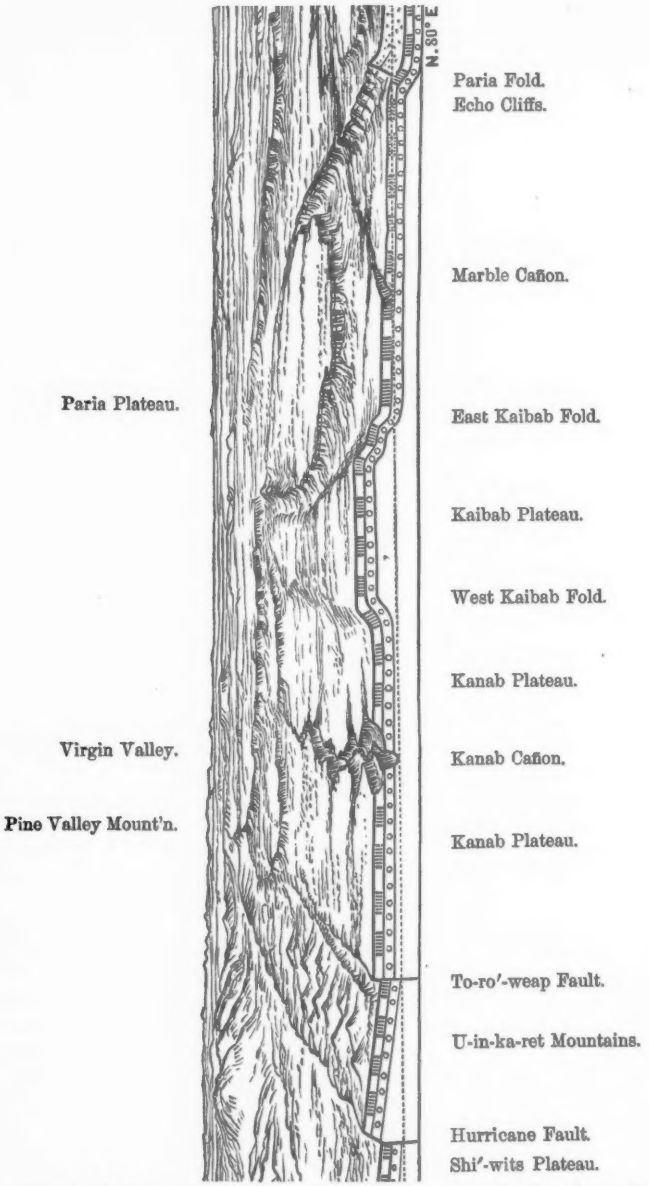


FIG. 3.—Section from west to east across the plateaus north of the Grand Cañon, with bird's-eye view of terraces and plateaus above. Horizontal scale, 16 miles to the inch; vertical scale, 4 miles to the inch.

displacement in a horizontal position; but every block is tilted more or less, and often a valley appears at the foot of the slope, and the streams which head on the opposite brink of the plateau have excavated valleys, leaving intervening ridges which project into the valley, having an effect somewhat like that described as one of the concomitant forms of the Uinta structure.

6. *Cliffs of Erosion.*—An inclined plateau may be bounded on the upheaved side by an escarpment of erosion, and such an escarpment is gradually carried back by an undermining process from the line of greatest upheaval. The drainage of such a plateau is usually from the brink of this escarpment toward the valley on the opposite side; yet a minor drainage is found which carves out deep gulches, and the cliffs of erosion have deep reëntrant and sharp salient angles.

7. *Buttes.*—Sometimes the gulches which form the deep, reëntrant angles of a line of cliffs have lateral gulches, which by continued erosion coalesce, and the salient angles are gradually cut off from the escarpment, which is ever retreating. In this manner buttes are formed as outliers of cliffs.

8. *Cameo Mountains.*—Wherever considerable areas of horizontal or nearly horizontal strata are found sufficiently elevated above the base level of erosion, and such areas are drained by two or more subparallel water-courses, the lateral drainage of these water-courses will gradually inosculate in their upper ramifications, and, carving out deep channels, will leave behind mountains of horizontal strata. Such mountains are often of great beauty. This is especially the case where the beds are of different texture and color, when the mountains will be terraced and buttressed in beautiful regularity, and banded with the colors which are characteristic of the several beds of which they are composed.

A few miles north of the Uinta Mountains, on the west side of the Green River, a group of such mountains is found, to which I have given the name Cameo Mountains, and I call this the Cameo structure.

V. *Basin Range Structure.*

When the blocks into which a district of country has been broken by faults are greatly tilted so that the strata dip at high angles, the uplifted edges of such blocks often form long mountain ridges. Such ridges have the general appearance of the monoclinal ridges already described as concomitants of other types of structure: but in this case the ridges constitute the chief mountain masses themselves, and form another general structural type. The monoclinal ridges are due to the erosion of upheaved strata; these ridges are due to displacement; they may also be eroded, but in so far as erosion has progressed the

ridge-like structure is obscured. Many of the ridge-like mountains of the Basin Province have this structure. Such a ridge is composed of monoclinal strata, the one side presenting a bold escarped front, the other a more gently sloped back conforming

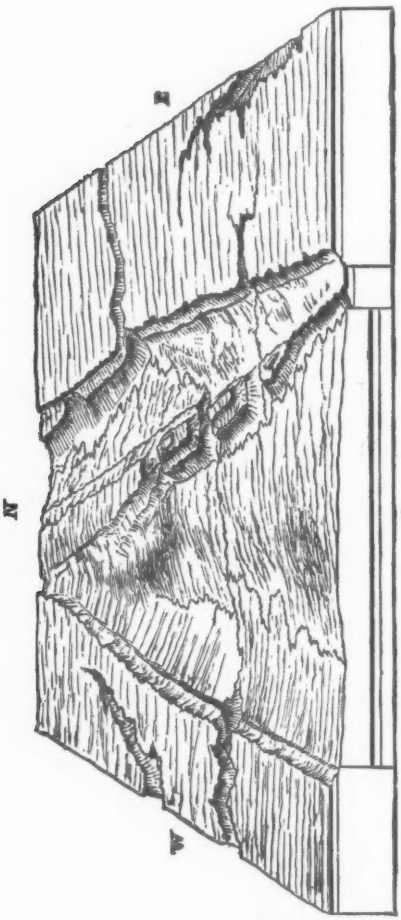


FIG. 4.—Bird's-eye view of a portion of the Muninia Zone of Diverse Displacement. The area represented is six miles square. The base line shows the sea-level. The tract is drained by Salina Creek, which unites its branches in the center and flows through the cañon on the left.

to a greater or less degree with the dip. Sometimes the ridges themselves are faulted longitudinally, transversely or obliquely, and the faults may be slight or of great magnitude; but the more common structure is a simple ridge with slight transverse or oblique faults.

CONCOMITANT FORMS.

1. *Monoclinal Ridges on the Back.*—On the backs of these Basin ranges monoclinal ridges have been observed.

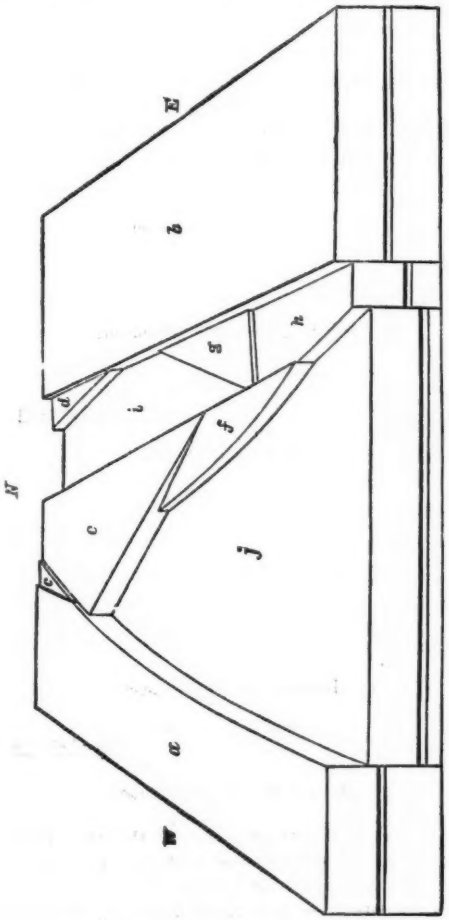


FIG. 5.—Deduced from Fig. 4. A restoration of the displaced rocks as they would appear had there been displacement but no degradation.

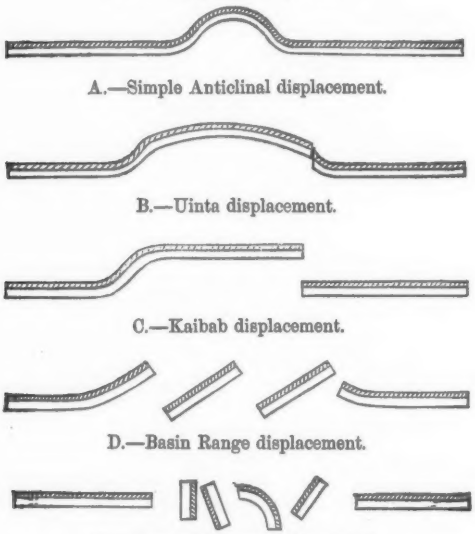
VI.—*Zones of Diverse Displacement.*

In this region many zones or irregular areas of country are found to be divided into small blocks by faults and flexures running in diverse directions, and these may be horizontal or be tipped at high or low angles, or even be overturned. The total effect of this diverse displacement may be to uplift the

area above, or depress it below, the adjacent country, or not to change its relative altitude. These features are exhibited on a small scale within a limited area, usually so elongated as to be termed a zone.

During the past season Mr. G. K. Gilbert has studied an area where this diverse displacement is by faulting, and the faults are of no great magnitude, and the blocks into which the area has been severed are either not tilted or but slightly so. This presents the simplest illustration of this type that has yet been discovered. It is simply the Kaibab structure on a very small scale. Fig. 4 is a bird's eye view of the blocks mentioned. In

FIG. 6.—Types of Displacement.



A.—Simple Anticlinal displacement.

B.—Uinta displacement.

C.—Kaibab displacement.

D.—Basin Range displacement.

E.—Zone of Diverse displacement.

the section, in the foreground, the heavy line represents the summit of the highest Cretaceous group. Fig. 5 is a diagram of the same region showing the blocks into which it is severed, and the same restored to the condition they would have, had there been no denudation.

On the south side of the Uinta Mountains, and east of the Green River, another comparatively simple area has been studied by myself. This zone of diverse displacement is on the flank of the great Uinta upheaval. These displacements are chiefly by flexures rather than by faults, and the blocks are more tilted and contorted than in the last.

In Atlas, plate No. 4, we have a stereogram representing these displacements, and in a subsequent chapter the subject is more fully discussed.

Many other areas far more complex than these have been discovered, where a zone has been broken into blocks, and these blocks tipped and contorted in diverse ways and directions, like the blocks of ice crowded in an eddy of a northern river at the time of its spring flood. The topographic features found in such areas are zones of irregular hills.

Figure 6 is a diagram illustrating the general types of displacement heretofore discussed. A represents a Simple Anticlinal displacement; B, a Uinta displacement; C, a Kaibab displacement; D, a Basin Range displacement; and E, a Zone of Diverse displacement.

Mountains composed in whole or in part of Extravasated Material.

We are not able in the present state of our knowledge to draw legitimate conclusions concerning the relation of the eruptive rocks, so widely distributed through all three of these geological provinces, but the following types of structure have been observed.

VII.—*Table Mountain Structure.*

We often find beds of sedimentary strata preserved from erosion by a capping of lava. Such are usually called table mountains; the underlying strata may be horizontal or inclined. Earlier stages of this structure are seen in *mesas* or low tables, and sometimes in valleys or gulches which have been filled with extravasated material, and erosion has proceeded to a limited extent on either side of these harder masses, carrying away the softer sedimentary material, and leaving the harder volcanic rocks in the midst of the valley; and this may have an elevation less or greater than that of the adjacent country beyond the rim of the valley.

A fine example of a table mountain is found in Pilot Butte, in Wyoming Territory.

VIII.—*Uinkaret Structure.*

Simple sheets of lava may be poured into a valley or on a plain, and serve as a protection to the sedimentary beds which are immediately underlying them, and as the erosion of the adjacent country not thus protected progresses, new vents may be formed along the edges of such sheets and at a lower level. Still erosion progresses, and still new floods of lava are poured out, and still at lower levels, until a mountain is left behind with its central mass composed of sedimentary material, but covered on the summit and flanks with irregular and overlap-

ping patches of lava. Thus lava bed is imbricated on lava bed, but unlike the tiles of a roof, the upper edge of the lower sheet is placed on the lower edge of the upper. This structure is well represented in the Uinkaret Mountains in Northern Arizona, and has been more fully discussed by me elsewhere. (*Vide* The Exploration of the Colorado River, &c., page 199 *et seq.*)

IX.—*Tu-Shar Structure.*

When a plain or valley which receives extravasated material from below remains at a base level of erosion during the period of successive eruptions, flood of lava is piled on flood of lava until a vast mass of material is accumulated from which the rains and streams carve mountains. The several beds of which such a mountain mass is composed are exceedingly irregular, from three causes: first, each bed as poured out was an irregular mass, due to its degree of fluidity and the character of the ground on which it was poured; second, each bed was more or less modified by erosion, which occurred after it was poured out, and before it was covered by a subsequent flood; and, third, the general mass has been eroded to a greater or less extent in producing the present forms.

The volcanic activity being in a region where movements of displacement are in progress, it is often the case that the structure of this class of mountains is greatly modified by such displacements. Mountains composed of such irregular beds of lava are of frequent occurrence in the region under discussion. A fine example is seen in the vicinity of the town of Beaver, Utah Territory, in what are known as the Tu-shar Mountains.

X.—*Volcanic Structure.*

When many eruptions come successively from the same vent, and each is a comparatively small amount, cones are built. Cones of such simple structure are of frequent occurrence in the region under discussion. Great complex cones such as are found in other parts of the world do not occur, but a few double and one triple cone have been observed. The great majority of the cones observed are built of cinders on broad sheets of lava, and are in fact concomitant forms of lava mesas. Such cones are comparatively ephemeral, as the scoria and ashes of which they are composed yield readily to atmospheric degradation. Where such a cone exists, still having a well defined crater, its condition testifies to the lateness of its origin, and all the facts relating to the sheet of lava on which it rests fully corroborate the conclusion. From such evidence we are able to infer the recency of much of the volcanic activity in the three provinces. If the human history of America could be carried back to as early a date as it has been in Asia, it cannot be doubted that the earlier chapters of that history would be replete with the accounts of volcanic fires.

XI.—*Henry Mountain Structure.*

Sometimes we find the sedimentary strata displaced by a quaquaversal upheaval and the same fractured, and through these fractures floods of lava have poured, and these may lie in patches about the flanks of the mountains, or stand in dikes where the walls of the crevice have been swept away by denudation. In the Henry Mountains we have a fine illustration of this type of structure. These mountains have been studied by Mr. Gilbert during the past season, and in his preliminary report he says: "The eruptions of the Henry Mountains are of a character entirely novel to me, and they were studied with an interest stimulated by surprise. A description of a single one, though it will not stand for all, will serve to illustrate the type.

Mount Ellsworth is round, and its base is six or eight miles broad. The strata of the plain about it are horizontal on every side. Near the mountain the level strata become slightly inclined, rising from all sides toward the mountain. At its base the dip steadily increases until on the steep flanks it reaches a maximum of forty-five degrees. Then it begins to diminish, and the strata arch over the crest in a complete dome. But the top of the dome has cracked open, and tapering fissures have run out to the flanks, and they have been filled with molten rock, which has congealed and formed dikes. Moreover, the curving strata of sandstone and shale have in places cleaved apart and admitted sheets of lava between them. So the mountain is a dome or bubble of sedimentary rocks with an eruptive core, with a system of radial dikes, and with a system of dikes interleaved with the strata. It is a mountain of uplifted strata, distended and permeated by eruptive rock."

* * * * * *

In the foregoing characterization of certain types of structure found in these regions, I have not attempted to adopt a system of exact classification, which should be both inclusive and exclusive as the types do not admit of such classification. No "hard and fast lines" can be drawn. I have simply attempted to indicate the important types with their primary and concomitant forms.

It is manifest that the structure of a sedimentary mountain will depend primarily upon two elements—the type of the displacement and the character and extent of erosion. The erosion may be antecedent or superimposed, or it may be consequent, or these methods may be combined, and the erosion may be modified by dip, texture, and other characteristics of the beds producing concomitant forms.

For convenience, I subjoin the following synopsis of the types of mountain structure recognized in the foregoing discussion.

I. MOUNTAINS COMPOSED OF SEDIMENTARY STRATA, ALTERED OR UNALTERED.

I.—*Appalachian Structure.*

(Not found in the three provinces.)

II.—*Simple Anticlinal Structure.*

Primary topographic form: Plateau with rounded vertical outline.
Concomitant forms: 1. Monoclinal Ridges on the Flanks. 2. Monoclinal Ridges only. 3. Inclined Plateaus.

III.—*Uinta Structure.*

Primary topographic form: Plateau with rounded summit and abrupt shoulders on the flank.
Concomitant forms: 1. Subsidiary Plateaus. 2. Projecting Ridges. 3. Axial Peaks. 4. Flanking Peaks. 5. Interrupted Monoclinal Ridges.

IV.—*Kaibab Structure.*

Primary topographic form: Plateau with angular outlines.
Concomitant forms: 1. Cliffs of Displacement. 2. Slopes of Displacement. 3. Interrupted Monoclinal Ridges on the Flanks. 4. Monoclinal Ridges with Plateau carried away. 5. Projecting Ridges. 6. Cliffs of Erosion. 7. Buttes. 8. Cameo Mountains.

V.—*Basin Range Structure.*

Primary topographic form: Monoclinal ridges of displacement.
Concomitant forms: 1. Monoclinal ridges on the back.

VI.—*Zones of Diverse Displacement.*

Topographic form: Irregular hills.

II. MOUNTAINS COMPOSED IN WHOLE OR IN PART OF EXTRAVASATED MATERIAL.

VII.—*Table Mountain Structure.*
VIII.—*Uinkaret Structure.*
IX.—*Tu-Shar Structure.*
X.—*Volcanic Structure.*
XI.—*Henry Mountain Structure.*

ART. XLVI.—*On the Ethers of Uric Acid. Contributions from the Chemical Laboratory of Harvard College;* by H. B. HILL,* Assistant Professor of Chemistry.

ALTHOUGH the constitution of many of the derivatives of uric acid may be said to be fairly established, the structure of uric acid itself is still a matter of conjecture. The formulæ given by Bäyer,† Kolbe,‡ Strecker,§ Erlenmeyer,‖ Mulder,¶ Hüfner,** Gibbs,†† Medicus,‡‡ Drechsel,§§ and Mallet;‖‖ dif-

* In great part from the yet unpublished Proceedings of the Am. Acad., p. 26.
† Ann. Chem. u. Pharm., cxxvii, 235.
‡ Journ. für prakt. Chem. II, i, 134. Berichte Deutsch. Chem. Gesellsch., iii, 183.
§ Zeitschr. für Chem., 1868, 363.
‖ Zeitschr. für Chem, 1869, 176. München. Acad. Ber., ii, 276.
¶ Bericht. der Deutsch. Chem. Gesellsch., vi, 1237.
** Journ. für prakt. Chem., II, iii, 23.
†† Am. Journ., II, xlvi, 289.
‡‡ Ann. Chem. u. Pharm., clxxv, 243.
§§ Journ. für prakt. Chem., II, xi, 352.
‖‖ Am. Journ., III, xi, 195 1876.

fering as they do, in points more or less essential, show that the experimental data are as yet insufficient to establish its structure. In this connection the ethers of uric acid seem to have attracted little attention. In 1864, Drygin* prepared the diethyl and triethyl ethers by the action of ethyl iodide upon diplumbic urate. I have been unable to obtain the original paper, but from the summary of it given in the Jahresbericht† for that year, and in Gmelin's‡ Hand-book, it would appear that he submitted them to no very extended examination. I have, therefore, undertaken the study of the ethers of uric acid, with the hope that a careful study of the products of their decomposition may throw additional light upon the structure of uric acid.

A few preliminary experiments convinced me that the compounds in the methyl series could be much more conveniently made than those of the ethyl or benzyl. I therefore began with the methyl ethers, and this paper gives the results I have obtained in the study of the first of these.

Methyluric acid, $C_5H_3(CH_3)N_4O_3$.

Methyluric acid may readily be prepared by the action of methyl iodide upon monoplumbic urate. The metathesis takes place slowly at 110°–130°, rapidly between 160° and 165°. The dry lead salt mixed with methyl iodide in molecular proportions, enough ether being added to keep the mixture fluid, is heated in sealed tubes for eighteen hours at 165°. After the evaporation of the ether, the product of the reaction is boiled with water, and the solution filtered from the unaltered plumbic urate. The lead is then precipitated with hydric sulphide, and the plumbic sulphide filtered off boiling hot. The filtrate deposits, on cooling, methyluric acid in small crystals. These are dissolved in dilute potassic hydrate, the solution boiled for a few minutes, reprecipitated by hydrochloric acid, and recrystallized from boiling water. The yield is about sixty per cent of the amount theoretically required by the lead salt which enters into the reaction. A portion of the uric acid is completely decomposed, and is found as ammonium salt in the mother liquors and the crude product. I attempted to increase the yield by employing anhydrous ether in the place of common ether. Although no ammonium compounds were then formed, a much smaller percentage of the lead salt entered into reaction. Longer heating at a lower temperature did not increase the yield, inasmuch as a larger quantity of dimethyl ether was then formed. The amount of dimethyl ether formed by heating to 165° is small; and as it is much more soluble in

* Russ. Zeitschr. Pharm., iii, 3, 28, 49, 113, 121.
† Jahresbericht, 1864, 629.
‡ Gmelin, Suppl., ii, 1026.

water than the monomethyl ether, it may readily be removed by recrystallization.

Methyluric acid crystallizes in small clear flat prisms, apparently of the trimetric system, the crystals being often pointed at either end. By slow cooling of a dilute solution, these crystals sometimes reach a length of 2–3 mm., but they are usually much smaller. The substance undergoes no visible change when heated to about 300°; at a higher temperature, it melts with complete decomposition, and without perceptible sublimation. It is soluble in boiling water, almost insoluble in cold water or in boiling alcohol; insoluble in ether. Cold concentrated sulphuric acid dissolves it abundantly; upon dilution it crystallizes out, apparently unchanged.

The substance dried at 165° has the formula $C_5H_3(CH_3)N_4O_3$, as the following analyses show:

1. 0·4284 grm. gave 0·1310 grm. H_2O, and 0·6210 grm. CO_2.
2. 0·2748 grm. gave 0·0985 grm. H_2O, and 0·3972 grm. CO_2.
3. 0·1822 grm. gave 50·0 c.c. nitrogen, at 20°·5, and 754·3 mm. press.

Calculated for $C_6H_6N_4O_3$.		Found. 1	2	3
C	39·56	39·53	39·43	
H	3·30	3·39	3·98	
N	30·77			30·98

As the mean of several determinations of solubility, I find that there are required for the solution of one part of methyluric acid 253·6 parts of boiling water, and 4596 parts of water at 20°.

The aqueous solution reddens litmus feebly, and decomposes carbonates readily on heating. A solution in potassic or sodic hydrate is not precipitated by carbonic dioxide. From a concentrated cold solution, stronger acids precipitate it gelatinous, from hot or dilute solutions crystalline.

With bases methyluric acid forms a series of definite salts, some of which have been studied by Mr. O. R. Jackson in this laboratory. The results of this investigation may be found in the Proceedings of the American Academy.* He has analyzed the following salts:

$K_2C_5H(CH_3)N_4O_3$ 3 H_2O
$KC_5H_2(CH_3)N_4O_3$ H_2O
$Na_2C_5H(CH_3)N_4O_3$ 3 H_2O
$NaC_5H_2(CH_3)N_4O_3$ H_2O
$BaC_5H(CH_3)N_4O_3$ $3\frac{1}{2}H_2O$
$Ba(C_5H(CH_3)N_4O_3)_2$ 4 H_2O
$Ca(C_5H(CH_3)N_4O_3)_2$ 3 H_2O

These salts show that the monomethyl ether of uric acid is

* Amer. Acad. Proc., xii, 36.

itself a bibasic acid like uric acid; a fact which is certainly remarkable and of obvious theoretical importance.

Action of Hydrochloric Acid.

In 1867, Strecker* showed that uric acid heated with fuming hydrochloric or hydriodic acid to 170° assimilates five molecules of water, giving carbonic dioxide, ammonia, and glycocoll,—

$$C_5H_4N_4O_3+5H_2O=3CO_2+3NH_3+C_2H_5NO_2.$$

The inferences which he drew† from this reaction concerning the structure of uric acid are well known. Emmerling‡ has recently shown that cyanogen gas passed into boiling hydroidic acid is converted into glycocoll, and seeks thus to give Strecker's reaction a new interpretation. In either case, however, it seemed to me of importance to determine the products of the decomposition of methyluric acid under these conditions.

Two tubes, each containing 1·3 grm. methyluric acid, and an excess of hydrochloric acid saturated at 0°, were heated four or five hours at 170°. The gas which escaped on opening the tubes was found to contain no methyl chloride. The excess of acid was driven off on the water bath, and the residue distilled with plumbic hydrate until the distillate was no longer alkaline. The ammoniacal distillate was caught in hydrochloric acid, and evaporated to dryness on the water bath. The residue was treated with a small quantity of absolute alcohol, and the filtered solution again evaporated to dryness. There was then left a white saline residue, which gave with great readiness Hofmann's isocyanide reaction, showing the presence of a monamine. The chloride was converted into the platinum salt, and this was analyzed after recrystallization from hot water.

0·4760 grm. gave on ignition 0·1991 grm. platinum.

	Calculated for $(CH_3NH_3)_2PtCl_6$.	Found.
Pt	41·61	41·82

Methylamine is, therefore, one of the products of the reaction.

From the residue left on distillation, it was easy to isolate glycocoll in the ordinary way. The liquid was filtered from the basic plumbic chloride, the lead removed from the solution by hydric sulphide, and the filtrate evaporated. On standing, glycocoll crystallized out with its characteristic properties. For its identification, it was converted into the copper salt by boiling with freshly precipitated cupric oxide, and precipitation of the blue solution by alcohol. Of this salt,—

* Ann. Chem. u. Pharm., cxlvi, 142; Zeitschr. für Chem., 1868, 215.
† Zeitschr. für Chem., 1868, 363.
‡ Berichte Deutsch. Chem. Gesellsch., vi, 1351.

0·4400 grm. lost at 130° 0·0388 grm.

	Calculated for $(C_2H_4NO_2)_2Cu \cdot H_2O$	Found.
H_2O	7·85	7·68

A determination of copper in the dry salt gave,—

0·4068 grm. left on ignition 0·1523 grm. CuO.

	Calculated for $(C_2H_4NO_2)_2Cu$	Found.
CuO	37·55	37·43

The reaction in this case may therefore be written,—

$$C_5H_3(CH_3)N_4O_3 + 5H_2O = 3CO_2 + 2NH_3 + CH_3NH_2 + C_2H_5NO_2.$$

It will be seen that this reaction proves the commonly accepted view that uric acid is not an hydroxyl but an imide acid.

In order further to establish the relative position of the methyl radical, it seemed to me of chief importance to follow it through oxidation in alkaline and acid solution, and thus determine its relation to allantoin and alloxan or paraban.

Methylallantoin. $C_4H_5(CH_3)N_4O_3$.

Methyluric acid is readily oxidized in alkaline solution, according to the method of Claus and Emde.* The solution must be dilute with but a small excess of alkali, the potassic permanganate added slowly in exact molecular proportion. As soon as the manganese dioxide has separated, it must be filtered rapidly with the aid of the pump, and the filtrate slightly acidified with acetic acid. I then found it most advantageous to evaporate as quickly as possible on the water bath to small volume. After standing twenty-four hours the methylallantoin crystallizes out in clusters of radiated prisms. These separated from the mother liquor by pressure, and recrystallized several times from hot water, form clear distinct monoclinic prisms, closely resembling ordinary allantoin. They are readily soluble in hot water, sparingly in cold; almost insoluble in alcohol, hot or cold, and insoluble in ether. These crystals melt with decomposition at 225°.

In spite of many variations of the method, I could obtain in this way but fifteen per cent of the theoretical yield. From the mother liquors evaporated to a syrup, alcohol separates a potash salt, probably of methylallantoic acid. On account of its uninviting character it was not further examined.

Methylallantoin dried at 100° gave, on analysis,—

* Berichte Deutsch. Chem. Gesellsch., vii, 226.

0·2362 grm. gave 0·1092 grm. H_2O, and 0·2978 grm. CO_2.

	Calculated for $C_4H_5(CH_3)N_4O_3$.	Found.
C	34·89	34·39
H	4·65	5·13

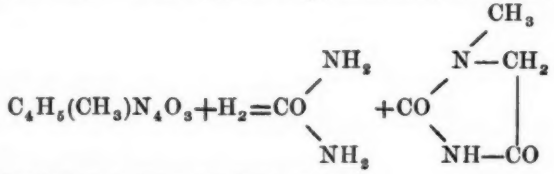
This substance is apparently isomeric with that described by Grimaux under the name Pyruvil.*

Silver nitrate gives in a hot saturated solution on the cautious addition of ammonic hydrate, a crystalline precipitate consisting of needles or short prisms. This salt is readily soluble in hot water, more sparingly in cold. By spontaneous evaporation of the cold solution, tolerably perfect crystals of the trimetric system were obtained. This compound may be dried, without decomposition, at 100°, and gave then on analysis,—

0·1668 grm. left on ignition 0·0646 grm. silver.

	Calculated for $AgC_4H_4(CH_3)N_4O_3$.	Found.
Ag	38·71	38·61

Bäyer† has shown that allantoin, when heated with hydriodic acid, breaks up into urea and hydantoin; and it was evident that methylallantoin should give an analogous reaction. I therefore heated methylallantoin with concentrated hydriodic acid, following the directions given by Bäyer.‡ When the reaction appeared to be ended, the liberated iodine was reduced with sulphide of hydrogen, and the hydriodic acid removed by plumbic carbonate. The filtrate gave on evaporation, after standing for some time, clear crystals, which, freed from the syrupy mother liquor, and recrystallized from water, formed transparent prisms, readily soluble in water or alcohol, and giving no precipitate with zincic chloride. Their melting point I found to be 144°–145°. The quantity at my disposal was insufficient for analysis, but there can be no doubt of the identity of this substance with methyl hydrantoin described by Neubauer§ as resulting from the action of baric hydrate upon creatinine, inasmuch as he gives these properties and the melting point 145°. The reaction may, therefore, be written,—



* Berichte Deutsch. Chem. Gesellsch., vii, 1790.

† Ann. Chem. u. Pharm., cxvii, 178. ‡ Ibid., cxxx, 158. § Ibid., cxxxvii, 288.

Once, as the action of the hydriodic acid was longer continued, I obtained a substance crystallizing in broad rhombic plates, readily soluble in water, sparingly soluble in alcohol, which gave a precipitate with an alcoholic solution of zincic chloride. These crystals melted at 105°, and sublimed readily at 100°. They were evidently sarcosine formed from the decomposition of methylhydantoin.

Oxidation of Methyluric Acid with Nitric Acid.

By the oxidation of methyluric acid with nitric acid, a solution is obtained which gives a deep red coloration on warming with ammonic hydrate. From this solution, however, I have as yet been unable to isolate a crystalline product. By spontaneous evaporation in the air, a sticky syrup is obtained, which does not solidify, even after long standing *in vacuo* over sulphuric acid. Alcohol dissolves this residue, the solution remains clear after the addition of ether, and on evaporation again leaves an uncrystallizable syrup. I have been equally unsuccessful in separating by stannous chloride or sulphide of hydrogen a crystalline alloxantine or dialuric acid. Oxidation with potassic chlorate and hydrochloric acid, according to the method of Schlieper,* gave the same result. These reactions were sufficient to give a qualitative proof that the solution did not contain ordinary alloxan. I therefore attempted to prepare from this solution a methylalloxanate in form fit for analysis. I first tried with baric hydrate to form the barium salt. The ordinary method, following closely the directions of Schlieper,† gave me, however, a salt containing but a trace of nitrogen and with percentages of barium, carbon, and hydrogen, closely approximating those required by a basic baric mesoxalate, $BaC_3O_5.BaO_2H_2$. At the same time a strong smell of methylamine was perceived. If a smaller quantity of baric hydrate were added in the cold, and then alcohol in excess, a barium salt was thrown down which contained nitrogen, but it could not in this way be obtained of constant composition. Plumbic hydrate seemed to determine the formation of the methylalloxanate, but no better results were obtained. The silver salt blackened too rapidly to admit of analysis.

The lime salt is the only one I have been able to prepare with constant composition. Methyluric acid is dissolved in as small a quantity of nitric acid of 1·42 sp. gr. as possible, the solution somewhat diluted, and the excess of acid neutralized with calcic carbonate in the cold. The solution is then allowed to stand *in vacuo* for some time, to free it from carbonic dioxide, afterwards diluted with six or eight volumes of alcohol and filtered. The cautious addition of ammonic hy-

* Ann. Chem. u. Pharm, lv, 261. † Ibid., 272.

date to the filtrate throws down a bulky semi-gelatinous precipitate, which, well washed with alcohol, and dried at 100°, forms an amorphous powder, which has a faint pink color,—undoubtedly caused by a trace of alloxan. The dry salt was soluble in cold water, though with some difficulty.

Analysis gave for substance dried at 100°—

1. 0·1778 grm. gave 0·1125 grm. $CaSO_4$.
2. 0·2275 grm. gave 0·1446 grm. $CaSO_4$.
3. 0·3049 grm. gave 36·8 c.c. nitrogen at 21°·5, and 762·1 mm. press.

	Calculated for $C_4H(CH_3)N_2O_3Ca$	Found. 1	2	3
Ca	18·87	18·61	18·69	
N	13·21			13·68

The analyses 1 and 2 were made with different preparations.

Inasmuch as the chief point was to prove the formation of methylalloxan by this oxidation, I distilled the calcium salt, prepared in the manner described, with potassic hydrate in a current of steam. The ammoniacal distillate readily gave the characteristic isocyanide reaction by heating with alcoholic potash and chloroform. It was neutralized with hydrochloric acid, evaporated, and from the residue the methylamine chloride separated by absolute alcohol. An analysis of the platinum salt gave—

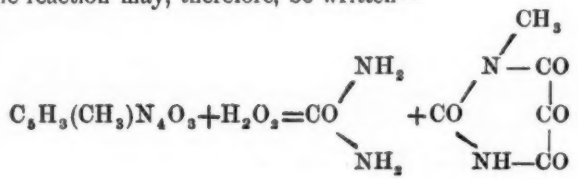
0·2160 grm. left on ignition 0·0902 grm. platinum.

	Calculated for $(CH_3NH_3)_2PtCl_6$	Found.
Pt	41·61	41·76

Thus proving that the calcium salt contained the group $=N-CH_3$.

In further confirmation, I was able to isolate common urea as the secondary product of the methylalloxan formation. After oxidizing with hydrochloric acid and potassic chlorate, the excess of acid was driven off by evaporation at gentle heat, the potassic chloride separated with absolute alcohol, and the alcoholic solution evaporated to a syrup. The cautious addition of strong nitric acid caused the separation of abundant crystals of urea nitrate in characteristic form. The base, set free as usual with baric carbonate, after recrystallization from water, melted at 129°–130°.

The reaction may, therefore, be written—



Methylparaban, $C_3H(CH_3)N_2O_3$.

Although methylalloxan is so unstable in the presence of bases, in acid solution it possesses remarkable stability. It may be boiled for some time with strong nitric acid, or with hydrochloric acid and potassic chlorate before the red coloration with ammonia disappears. On prolonged boiling (about an hour) with strong nitric acid, the oxidation is complete, and the solution contains methylparaban. For its preparation I have found it most advantageous to boil methyluric acid with five or six parts of nitric acid of sp. gr. 1·3, until a drop taken out gives no coloration with ammonia. The excess of acid is then driven off on the water bath, the syrupy residue diluted with a little water, and well shaken out with ether. On distilling off the ether, a syrup remains which soon crystallizes in shining radiated prisms, which are recrystallized from hot water. They are somewhat difficultly soluble in cold water, readily in hot; soluble in alcohol and ether. The substance melts at 149°·5, sublimes very slowly at 100°, and at higher temperature with great readiness. For analysis, the air-dried substance was heated three hours at 100°; during that time 0·2260 grm. lost 0·0030 grm.

1. 0·1714 grm. gave 0·2333 grm. CO_2.*
2. 0·2160 grm. gave 0·0785 grm. H_2O, and 0·2629 grm. CO_2.

	Calculated for $C_4N_2H_4O_3$	Found. 1	2
C	37·50	37·12	37·48
H	3·13		4·04

The substance gives no precipitate with calcic chloride, even after the addition of ammonic hydrate. On warming the ammoniacal solution, a precipitate falls not wholly soluble in acetic acid. Argentic nitrate precipitates it only in concentrated solution. The silver salt prepared from concentrated solution, with the cautious addition of ammonic hydrate, crystallizes in prismatic needles; quite readily soluble in hot water, sparingly in cold. Under the microscope it crystallizes from hot aqueous solution in rhombic plates. It may be dried at 100° without decomposition. It gives on analysis,—

0·1210 grm. left on ignition 0·0556 grm. silver.

	Calculated for $AgC_4N_2H_3O_3$.	Found.
Ag	45·95	45·95

There can be no doubt that this substance is identical with that obtained by Dessaignes† from creatinine, which was first recognized by Strecker‡ as methylparaban. Dessaignes gives

* The hydrogen in this analysis was lost.

† Ann. Chem. u. Pharm., xcvii, 343. ‡ Ibid., cxviii, 164.

no melting point, but the description given corresponds perfectly with the substance I have obtained; the only difference being that I find the substance quite readily soluble in ether, whereas he gives it as somewhat soluble only.

Although I must postpone all discussion of the structure of uric acid until the investigation upon which I am at present engaged is farther advanced, I may perhaps be pardoned if I consider briefly the structure of urea which must of necessity form the foundation of any formula of uric acid. It certainly would not have occurred to me that any such consideration of its structure were necessary had not Professor Mallet in his recent paper on uric acid and its derivatives in this Journal,* adopted the formula $C\begin{matrix}NH_2\\NH\\OH\end{matrix}$, which was proposed several years ago at about the same time by Wanklyn and Gamgee† and Gibbs.‡ Professor Mallet hardly discusses in his paper the facts bearing upon its structure, but contents himself with pointing out the simplicity which he believes this formula will give to its complex derivatives,—a style of argument serviceable enough, where there is little or no choice upon other grounds, but certainly not to be trusted, if opposed by direct synthetic reactions.

The facts remain, as far as I know, essentially as they were when the whole matter was reviewed by Heintz.§ Basarow‖ proved in Kolbe's laboratory the formation of urea from ammonic carbonate and carbamate. Natanson¶ showed that it was formed by the action of ammonia upon carbonyl chloride and ethyl carbonate, and his results were afterward confirmed by Neubauer and Kerner.** By these syntheses urea is shown to be directly connected with carbonic acid as its amide by the three principal general reactions for the formation of amides, and no formula but $CO\begin{matrix}NH_2\\NH_2\end{matrix}$ can explain these reactions without the gratuitous resort to molecular rearrangement. Very recently the reaction with carbonyl chloride has been employed by Michler†† in the formation of fourfold substituted ureas: $CO\begin{matrix}Cl\\Cl\end{matrix}+\begin{matrix}HN(C_2H_5)_2\\HN(C_2H_5)_2\end{matrix}=CO\begin{matrix}N(C_2H_5)_2\\N(C_2H_5)_2\end{matrix}+2HCl$, leaving no possible doubt of the symmetrical distribution of the hydrogen atoms in urea.

Against these syntheses but two facts have been urged:

* This Journal, March, 1876, p. 185.
† Journ. Chem. Soc., II, vi, 25.
‡ This Journal, Nov., 1868, p. 289.
§ Ann. Chem. Pharm., cl, 67.
‖ Zeitschr. für Chem., 1868, 204.
¶ Ann. Chem. Pharm., xcviii, 287.
** Ann. Chem. Pharm., ci, 342.
†† Berichte Deutsch Chem. Gessell., vii, 1664.

first, the monobasic character of urea, and secondly Wanklyn and Gamgee's oxidation with alkaline permanganate.

As for the basicity of urea, Heintz* has already shown that basicity does not always correspond to the number of amide nitrogen atoms, and that amidogen, like hydroxyl, is largely dependent for its character upon the nature of the radical to which it is attached. As especially pertinent he instances oxamide, which is neutral although undoubtedly a diamide. An entirely different case in its nature, although perhaps still more to the point is guanidine $C\begin{matrix}NH_2\\NH\\NH_2\end{matrix}$, which is monobasic only. According to every analogy, therefore, the observed basicity of urea is but the normal behavior of carbamide.

The experiments of Wanklyn and Gamgee† were five in number. Two were made upon urea, two upon ammonium salts, and one upon acetamide. They found with an excess of permanganate that urea gave up all its nitrogen as gas, while the nitrogen of the ammonia and of acetamide was oxidized to nitric or nitrous acid. It may well be questioned, I think, whether these results are sufficient to form the basis of any generalization as to the behavior of "admitted amides," still granting that urea is thus distinguished from all other amides the proof is yet to be brought that the formula $C\begin{matrix}NH_2\\NH\\OH\end{matrix}$ possesses any advantages in explaining this observed decomposition. What experimental facts, what analogies, what plausible theory even can be given to justify the assumption that the nitrogen atoms in $CO\begin{matrix}NH_2\\NH_2\end{matrix}$ and $C\begin{matrix}NH_2\\NH\\OH\end{matrix}$, under the conditions employed by Wanklyn and Gamgee, would differ so fundamentally in their behavior? Anomalous as the decomposition of urea may be, it certainly is not to be explained by so simple a device as the substitution of one imide nitrogen for an amide. If this anomalous behavior should be established by further investigation of other diamido compounds, it would not be the first case in which the mono-carbon compounds differed essentially from their higher homologues.

I have thus briefly given my reasons for dissenting from Professor Mallet's assertion that the structure of urea is by no means settled. I can not but think it established by evidence as unequivocal as our present methods of research are capable of giving.

* Loc. cit., p. 74. † Journ. Chem. Soc., 1868, p. 25.

Harvard College Laboratory, Sept., 1876.

ART. XLVII.—*Notice of a Meteorite, from Madison Co., N. C.;* by B. S. BURTON, University of East Tennessee.

THIS meteorite was placed in my hands for examination by Professor F. H. Bradley, who also furnishes the following facts in regard to its history:

"The mass was found in August, 1873, on land of Robert Farnesworth, near Duel Hill, Madison Co., North Carolina. It was lying on a hillside where it had been used, probably, by the first settlers of the land in supporting a corner of a rail fence, now rotted away. It is said to have weighed, when first found, about twenty-five pounds. Two or three pounds of 'specimens' had been hammered off before I secured it, most of which could not be recovered. Mr. Farnesworth reported that a similar mass weighing about forty pounds had been found about a mile farther west, before the war, perhaps about 1857, which had since disappeared, probably has become buried in rubbish. Efforts to find it again were unsuccessful."

This meteorite consists of metallic iron, of a rounded irregular shape, with the usual coating of magnetic oxide, and measuring $9\times6\frac{1}{2}\times3\frac{1}{2}$ inches, and weighed twenty-one pounds. Over the surface at various points was a small bead-like deliquescence of iron chloride. A portion was cut off at a machine shop, though only after considerable trouble, and described by the machinist as "the toughest piece of iron" he had ever handled. After polishing, and by the action of acid, the usual markings appeared, though rather indistinct; and, at the same time, were developed distinct particles of Schreibersite irregularly disseminated over the surface, which by continued action of the acid stood out more prominently.

Specific gravity = 7·46. Iron not passive. Dissolves in hydrochloric acid, without liberating sulphuretted hydrogen, leaving a very slight, black, carbonaceous residue, which contained SiO_2, Fe, Cr, Ni, P.

The following result was obtained on about one gram of the iron:

Iron	94·24
Nickel	5·17
Cobalt	0·37
Phosphorus	0·14
Copper	trace
Residue	0·15
	100·07

ART. XLVIII.—*On a Recent Discovery of Carboniferous Batrachians in Nova Scotia;* by J. W. DAWSON, LL.D., F.R.S.

1. *General Remarks.*

THE erect Sigillariæ enclosed in the sandstone overlying coal-group 15 of Section XV, Division 4 of the South Joggins section, are perhaps the most remarkable repositories ever discovered of the remains of Paleozoic land animals. As I have shown in discussing their character in my memoirs on the South Joggins Coal Formation,* and my "Acadian Geology," some of these trees became embedded in sandy deposits, and being rendered hollow by decay of their inner bark and the crumbling of their woody axes, remained for a long time as open holes or pits, gradually filling with vegetable debris and the wash of rains and land floods. They thus became places of habitation for land snails and millepedes, and pit-falls into which the smaller batrachians, prowling for prey among the undergrowth of the coal forest, fell and were unable to extricate themselves. In this way the successive layers of deposit became stored with skeletons of batrachians which they have retained in an admirable state of preservation.

Only one sandstone at the Joggins is known to contain these reptiliferous trees, though erect Sigillariæ are known at more than sixty different levels, and many of these erect stumps have been broken up in the hope of making such discoveries. In the past summer, however, shells of *Pupa vetusta* were found by Mr. Albert J. Hill and the writer in an erect tree in Section XXVI of Division 4, about 800 feet higher in the series; and of course where these shells occur remains of other land animals may also be discovered.

Since the discovery by Sir Charles Lyell and the writer of the remains of *Dendrerpeton Acadianum* in one of the erect trees of group 15, I have several times visited the locality, and have endeavored to take advantage of the exposure of new trunks by the encroachments of the sea. In the summer of 1859 I took down a second stump which afforded nine skeletons of four species, as well as remains of Millepedes and shells of Pupa. In 1860, I dissected two other stumps, which yielded six additional skeletons including two new species. In the whole six batrachian species were more or less perfectly represented, and were described by Prof. Owen or myself. Mr. Scudder subsequently made a careful study of the remains of Millepedes, and referred them to five species belonging to two genera.† In the present year another tree very richly stored

* Journal of Geological Society of London, vols. ix, x, xi, xvi, xviii, xix.

† Air-breathers of the Coal Period, 1863. Acadian Geology, 1868, pp. 362 and 495. Scudder in Memoirs of Boston Soc. of Nat. History, 1873.

with remains was obtained, and its contents will form the subject of the present communication. Two others were extracted for me by the kindness of Mr. Hill, superintendent of the Cumberland Mine, but proved to be filled merely with sandstone without animal remains. This is an illustration of the fact that, even in this bed, only certain trees remained open long enough to become burial places of land animals.

All the remains found in these singular repositories are those of air-breathing animals, except certain worm-like bodies of uncertain nature, which Mr. Scudder suggests may be remains of Leeches. Further, as the reptiles which fell into these pits could have been only such as were capable of walking on land, the erect trees contain none of the ichthyic and elongated forms which have been described from Ireland, from Germany and from Ohio.* Such forms no doubt existed in Nova Scotia, but could not be laid up in coffins formed of Sigillaria trunks. The species preserved in these are therefore all of more or less lizard-like form, and have well developed limbs. Some of them, as we shall find, are also remarkable for ornate cuticular appendages, more akin to those of modern lizards than to those of batrachians. Again, though we know from the footprints of *Sauropus unguifer*,† found in Cumberland County at no great distance from the Joggins, and from those of *Sauropus Sydnensis*‡ found in Cape Breton, as well as from the osseous remains of the alligator-like *Baphetes*, that there were large terrestrial Labyrinthodonts in the coal swamps of Nova Scotia, these were of course too bulky to fall into the erect Sigillariæ; consequently the remains found are those of the smaller species only.

The state of preservation of the specimens is also peculiar. All the bones of each specimen are sure to be present; but inasmuch as most of the carcases had time to decay completely before they were finally covered up, the bones are often much scattered, and have apparently fallen into the interstices of the vegetable fragments on which they lay, so that the skeletons are usually disarticulated, and the bones, though individually perfect, are so entangled in the matrix that it is impossible to uncover the whole of them. In other, though rare cases, the body seems to have been covered at once, and its soft parts, and especially the skin, being either preserved by the tanning action of the vegetable matter, or converted into adipocere, remain in a coaly state, and completely cover the bones, so that these cannot be extracted except in fragments and by the destruction of the cuticle which invests them. Thus, while these remains afford the greatest facilities for the detailed and

* By Huxley, Von Meyer and Cope. † Geological Magazine, vol. ix.
‡ Acadian Geology, p. 358.

even microscopic examination of the parts, they do not often furnish skeletons with their members *in situ*, as in many of those described by Von Meyer, Huxley and Cope.

The tree of 1876 was found by me in "the reef" or extension of the sandstone seaward, and near the low-water mark. The upper part of the stump, probably filled with sandstone, had been removed by the waves, but about two feet of the lower part remained. It was extracted with as much care as possible by two miners with picks and crowbar, and the disk-like fragments, into which it naturally split, were carried up to the foot of the cliff and subsequently numbered and dissected at leisure. In the hurry of working against time to escape the tide, the men it seems left in the hole a portion of the lowest layer, and a fragment of an upper one. The former was afterwards removed by Mr. J. C. Russel of Columbia College, New York, and the latter was found by Mr. Hill. Both have been kindly placed in my hands by these gentlemen, so that the whole of the material has been collected and carefully labelled, in such a manner as to keep together the parts belonging to each skeleton.

This tree was about eighteen inches in diameter, and in the lower part was partially flattened by lateral pressure, so that its diameter in one direction was only a little over a foot. The material filling the somewhat thick coaly bark may be described as a more or less arenaceous silt or soil, blackened with vegetable matter, and replete with fragments of carbonized bark, mineral charcoal and fine vegetable debris. There are also numerous leaves of *Cordaites*, and abundance of the fruits which from their frequent occurrence in such hollow trees, I have elsewhere named *Trigonocarpum sigillariæ*. In some places the sediment was finely laminated, the laminæ being often much contorted. In other places the earthy matter existed in patches or interrupted layers, nearly free from vegetable matter, and especially abundant toward the sides of the trunk. The cementing substance is in general carbonate of lime, many portions of the mass effervescing freely with an acid, but in some spots there are hard concretions of pyrite. The material has evidently been introduced gradually, in small quantities at a time, and the earthy matter seems to have run down the sides, spreading more or less toward the center; but in general accumulating around the circumference. The number of skeletons recovered in a more or less complete state was no less than thirteen in all, belonging probably to six species, besides other bones contained in Coprolites, and several Millepedes, and shells of *Pupa vetusta*, the latter almost entirely in the lowest layers.

The first animal introduced was a specimen of *Hylerpeton Dawsoni* Owen, whose bones and scutes, after decay of the

connecting parts, had slid down the slope of silt from one side toward the center of the space. Next, after a few inches of filling, came a specimen of *Dendrerpeton Acadianum* Owen, whose bones lie along the center of the layer and nearly in one plane. Above this a large flake of bark had fallen in, forming an imperfect floor over the remains. Then, after an inch or two of carbonaceous matter had been deposited, came a somewhat flat surface which seems to have remained uncovered for some time, and on this lie the *disjecta membra* of three skeletons belonging to *Dendrerpeton Acadianum*, *D. Oweni*, and a new species of *Hylerpeton*. Above this was a confused mass of considerable thickness, in which were found another specimen of the new *Hylerpeton*, and remains representing a third animal of the same or an allied genus, also four specimens of *Hylonomus Lyelli*, and portions apparently of an immature *Dendrerpeton*. Still higher in position, was a layer with large portions of the cuticle of a *Dendrerpeton*, probably *D. Acadianum;* and above this, at the surface of the stump, were some remains and impressions of bones probably indicating another specimen of *Dendrerpeton*. Taking these specimens in the order above given, we may notice the new facts which they have disclosed on a preliminary examination.

2. *Remains of Hylerpeton.*

The sole species of this genus heretofore known, *H. Dawsoni*, was discovered by me in 1860, and was described by Professor Owen from remains so scanty that he expressed considerable doubt as to its affinities. I afterward worked out, from a few fragments of the matrix, the evidence that its teeth were simple, without plicated dentine, that it had a large canine or tusk in the anterior part of the upper jaw, and that it possessed a walking foot. The present specimen throws much additional light on its structure. It had at least twelve teeth in each ramus of the mandible, and they are large in proportion to the size of the animal, bluntly conical and somewhat acuminate. and faintly striate at the apex. The vomerine bones are beset with numerous small blunt teeth. The skull is long, and its bones thin and marked merely with delicate incised lines rather than wrinkles. The forms of the stout ribs and scattered vertebræ would indicate that the body was broad and squat. The skull must have been about two inches in length, the body probably four or five, and there are some small vertebræ which may indicate a short tail. The limbs were large and strong, the femur being an inch and a quarter long, and its shaft a fifth of an inch in diameter and with thick bony walls. The vertebræ are short and biconcave, and with large dorsal spines, the belly was protected by numerous imbricated bony scales of two

kinds, one oblong and narrow, the other broad and obliquely shield-shaped. There are indications of thoracic plates of larger size than the scales. On the whole this species was probably a somewhat clumsy creature, of toad-like form and slow gait, and with a dentary apparatus suited to pierce and crush crusts and shells. It is perhaps significant of its habits, in these respects, that the layers of this tree in which its bones occur are alone those in which shells of *Pupa vetusta* are found.

The second species of *Hylerpeton*, which I may provisionally name *H. longidentatus*, was of somewhat smaller size, with the bones of the skull thinner and more slender, and the teeth very long and sharply pointed, with the apex finely striate but with no corrugation of the dentine. The vomer is covered with minute teeth, and there are long and slender canines. The best preserved mandible shows eighteen teeth which are strongly inclined backward. The scales are very narrow and there is a large thoracic plate. The general form of body may have been as in the last species, but the skull was probably narrower and the feet longer.

Another species of this genus, or belonging to a genus intermediate between it and *Hylonomus*, is represented by a confused mass of bones showing long and narrow jaws, armed with short and blunt teeth, of which, at least thirty occur on each side of the lower jaws. The sculpture of the bones is as in the previous species, but the pulp-cavities of the teeth are smaller and their walls stronger, and they show no sculpture on the apex; in which respects they resemble those of *Hylonomus*. The vertebræ also are more elongated and the femur is a large bone indicating a powerful hind limb. The abdominal scutes are very long and narrow, resembling slender semi-cylindrical rods, a point in which this species differs from all the others found with it, although it resembles some of those found in Ireland and Ohio. This species I would name provisionally, in allusion to the form of its teeth, *Hylerpeton curtidentatum*.

In all these species of *Hylerpeton*, the teeth are simple, and are anchylosed to the bone and placed in linear series in a shallow groove.

3. *Remains of Dendrerpeton.*

The remains of this genus will afford additional facts as to the differences in individuals of various ages, and as to the details of the skeleton in the species *D. Oweni*, previously known by only one imperfect example. The specimen now found would seem to show that it resembled very much the larger species, except in the form of the teeth and scales. But the most interesting facts presented by a cursory examination of the specimens relate to the skin and its appendages. It is

now evident that in addition to the abdominal and gular scales, *Dendrerpeton* possessed thoracic plates of considerable size, resembling those of other Labyrinthodonts. The large mass of skin found in the tree of 1876, taken in connection with the smaller portions found on previous occasions, and described in detail in my "Air-breathers of the Coal-period," enables us to form a very good general idea of the appearance and clothing of the animals of this genus. To the naked eye the skin presents a shining and strongly rugose surface, reminding one of that of modern newts when contracted by immersion in alcohol, though on a coarser scale. Under the lens, the surface appears granular and with a higher power the granulation is seen to result from minute scales imbedded in the cuticle, and much smaller than those, in previous finds, which I have referred to *D. Oweni* and to *Hylonomus*. On some portions of it there are delicate transverse lines about a quarter of an inch apart, and apparently corresponding to those which on the newts and Menobranchus mark the bands of subcutaneous muscles. The bony scales of the abdomen have disappeared, except a few scattered in the matrix. But the most remarkable dermal appendages, are those triangular lappets or frills of which I have in previous papers described detached examples, and have compared them with the gular and cervical lappets and frills of iguanas, geckos and Draco; and which also suggest analogies with the processes that support the gills in perennibranchiate batrachians, and with the lateral folds of the skin in Menopoma. These appendages are flat and of appreciable thickness, about half an inch in length, and an eighth of an inch in breadth, terminating in an edge or obtuse flat point, which seems to have been horny, while the appendage itself must have been flexible. They are marked with small scaly oval areoles or projections, placed somewhat in rows, and each with a minute puncture in its center. The markings on both sides are similar. These appendages are arranged in series along what appears to be the skin of a fore leg, and also in groups apparently on the anterior part of the body, perhaps the neck or shoulder. They appear to be closely connected with a series of much smaller angular points which extend along the edge of the skin near the supposed leg, and probably fringe the sides of the abdomen. The evidence that this integument belongs to *Dendrerpeton Acadianum* is derived from the presence in its anterior part of skull-bones having the markings of that of this species, and from the occurrence of a jaw and other bones in the neighboring matrix. The specimen to which the skin belonged may have been about a foot in length. Taking it in connection with what is known of the skeleton, we can reproduce the external appearance of the animal. It was

lizard-like in form, with a somewhat flat and broad head and strong teeth with folded dentine. Its back was covered with a shining skin filled with microscopic horny scales. Its sides were marked by vertical bands separated by delicate indented lines. Anteriorly it was ornamented with numerous cutaneous lappets or pendants. The sides were bordered with a row of sharp horny points, and the throat, thorax and abdomen were protected by bony scales and plates, the scales of the throat being narrow and small and arranged in a chevron pattern.

Dendrerpeton Oweni probably had the scales of the back and the horny appendages larger in proportion, that is, if I have rightly referred to that species some similar remains to those above mentioned, found in 1859. *Hylonomus Lyelli* had a far more ornate set of cutaneous appendages, as evidenced by remains of skin found associated with its bones, also in 1859.* The tree of 1876 contains no cuticular remains referable to these species.

4. *Remains of Hylonomus.*

The bones of this genus are all, I think, referable to *H. Lyelli*, and to specimens about the size of those previously found. They throw little additional light on its character, except to indicate that it was probably very abundant, and to render it probable that the specimens formerly described were adult. Two of the skulls in the tree of 1876 are better preserved than those previously known, and confirm the statement already made as to the smoothness of the bones and the greater cranial elevation as compared with other batrachians of the Carboniferous period. This is indicated, among other things, by the skulls lying upon one side, which is not found to be the case with the other species.

In the admirable Report by Cope on the Batrachians of the Coal-formation of Ohio,† he places *Hylonomus* in the same family, *Tuditanidæ*, with *Dendrerpeton*. This I think does not express its true affinities. The more elongate and narrow skull, with smooth bones, the differently formed vertebræ, the teeth with non-plicated dentine, the different microscope structure of the bone, the more ornate dermal appendages, all separate these animals from the Labyrinthodonts, and entitle them, as I have formerly held, to a distinct position as an order or sub-order, for which I proposed in 1863 the name *Microsauria*. I observe that in the report on the Labyrinthodonts prepared by Mr. Miall for the British Association in 1873, and in the Tabular View appended to it in 1874, while the group *Microsauria* is retained, *Dendrerpeton* is placed in it, as well as *Hylerpeton*

* Journal Geol. Soc., vol. xvi, also "Air-breathers," 1863.

† Paleontology of Ohio, vol. ii.

and *Hylonomus*. This I think is an error in so far as the first genus is concerned. I may add my continued conviction that *Hylonomus* and its allies present many points of approach to the lacertian reptiles, which I hope in future to be able to work out more in detail.

Several masses of Coprolite, filled with small broken bones, were obtained in breaking up the material surrounding the skeletons. I presume these bones belong to one or other of the smaller species of *Hylonomus;* but I have not yet found any of them to be sufficiently characteristic to warrant any confident statement on the subject. These Coprolites must have been produced by *Dendrerpeton* or *Hylerpeton*, most probably the former.

The above statements must be regarded as imperfect, and preliminary to more detailed description and illustration of the specimens. These will require long and patient work and microscopic examinations of the bones and the teeth, and when this is completed they will be placed in relation, as far as possible, with the remains previously found in Nova Scotia, and with what is known of coal batrachians elsewhere.

I think it quite possible that further examination may enlarge the number of species above mentioned. I have been guided mainly in the reference of the specimens to species by the structure of the teeth and the cranial bones; but some of these may yield new points of difference on further study. As all the specimens are preserved under the same conditions, there is less liability here, than in most cases, to multiply species unduly, in consequence of different states of preservation.

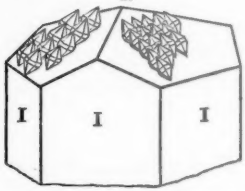
The fact that Cope has been able to catalogue, in his recent Report,* 39 genera of Carboniferous batrachians, including about 100 species, and that these present so wide a range of size, structure and general conformation, affords a very remarkable illustration of that simultaneous occurrence of many forms of one type, which appears in so many other groups of fossil animals; and is particularly striking in this first known group of air-breathing vertebrates, which since 1843 have swarmed upon us from the coal-fields of both continents, and of which we probably know as yet but a small fraction of the species. It remains to be seen whether the Devonian, so rich in its land flora, and which has already afforded remains of insects, may not disclose some precursors of the Carboniferous batrachians.

* Paleontology of Ohio, vol. ii.

ART. XLIX.—*Mineralogical Notes.* No. IV; by EDWARD S. DANA, Ph.D.—*On the association of crystals of Quartz and Calcite in parallel position, as observed on a specimen from the Yellowstone Park.*

THE occurrence of crystals of quartz in parallel position upon the faces of a rhombohedron of calcite was long since described by Breithaupt. The relation of the two minerals is shown in figure 1, given by him; each crystal of quartz has its pyramidal face parallel to the rhombohedron ($-\frac{1}{2}R$) of the calcite. Breithaupt also mentions specimens in which the calcite had been removed, and the resulting form he speaks of under the head of *pseudomorphs* of quartz after calcite, as a "trilling" of quartz.*

1.



A somewhat analogous case was described by Rose† and Eck‡ from Reichenstein in Silesia; more recently vom Rath and Frenzel§ have given a full description, illustrated by a number of figures, of a similar occurrence from Schneeberg, Saxony. In the specimens described by them the calcite rhombohedron ($-\frac{1}{2}R$) was completely enveloped by the quartz. Each rhombohedral face of the former having upon it a pyramid of quartz, united by a pyramidal face, and the extension of these six crystals regularly had produced a form which with its reentering angles appeared to be a trilling (a compound crystal of three combined crystals) of quartz. It was further shown by vom Rath that the calcite alone had determined the position of the quartz crystals, and consequently that the form, which had resulted, was only a *pseudo-trilling.* Both the vertical twinning-plane, and the horizontal plane of the compound crystal were pronounced to be impossible forms with quartz.

Many cases of the association of crystals of different species in parallel position have been observed (as for example, of albite on orthoclase, of pyroxene on hornblende, of chrysolite and humite, etc.), but the case here mentioned is of an exceptionally anomalous character. It is a matter of some interest, therefore, to note the discovery of a new case of this association of quartz and calcite and one which offers some features not before observed, affording at least a partial explanation of this geometrical relation between the two minerals.

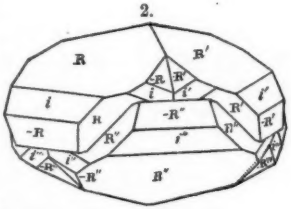
* Berg- u. Hütten. Zeit., 1861, 54.
† G. Rose, Pogg. Ann., lxxxiii, 461.
‡ H. Eck, ZS. G. Ges., xviii, 426.
§ Pogg. Ann., clv, 17, 1874.

The specimen in hand was obtained by the writer in August, 1875, when visiting the Yellowstone National Park in connection with the party of Col. William Ludlow, U. S. A. It was found in the neighborhood of what has been called "Specimen Mountain," a locality which has furnished many fine amethysts, geodes of chalcedony, and fragments of silicified wood. The rock is an igneous conglomerate.

The specimen itself consists mostly of chalcedony, upon the surface of which have been implanted rhombohedrons ($-\frac{1}{2}R$) of calcite, and finally, as a still later process, the quartz has incrusted both the calcite crystals and simultaneously the exposed surfaces of the chalcedony. In the latter position a simple drusy surface of fine quartz crystals, irregularly planted, has resulted, but the crystals upon the calcite, though unquestionably of simultaneous formation, are all in a similar parallel position, analogous to that shown in fig. 1; the pyramidal faces of the quartz crystals (R or $-R$) being parallel to the rhombohedral ($-\frac{1}{2}R$) face of the underlying calcite. In some cases a collection of small parallel crystals of quartz form a coating upon each rhombohedral face, but more generally these crystals are so developed as to be united, forming perfectly smooth continuous faces parallel to those of the calcite. Some of the crystals of calcite are half an inch or more in length, and the continuous layer of quartz has a thickness of about $\frac{1}{2}$ mm., completely enveloping them. This coating may be readily removed, leaving the calcite crystal entire. The completed form, as remarked by vom Rath, has a most anomalous appearance, and one likely to puzzle the careless observer.

The general appearance of the crystals is very uniform; it is shown in fig. 2. In the smaller crystals ($\frac{1}{8}$ to $\frac{1}{4}$ inch broad), the symmetry of the planes was nearly as perfect as in the drawing. A comparison of this figure with those given by vom Rath will show that though in the main features similar, still the one here given differs in some most important respects.

2.



The first examination of the crystals suggests the probable existence of the zones (fig. 2) i, $-R$, $-R'$, i''; also i, R, R'', i'', $-R''$, $-R^{IV}$; and i', R', R''', i'', $-R''$, $-R'''$. The three cases as they are continued around the crystal are obviously repetitions of the same series of planes. A more critical study of them, however, by the aid of the reflecting goniometer, shows that they are really only *pseudo-zones*, although it is seen at the same time that the deviation from perfect parallelism is very slight. It is in fact a remarkable case of *pseudo-symmetry*.

The following angles were measured in these "zones," as they may for convenience be called. A double-telescope goniometer was employed for the purpose, though the character of the planes was not such as to allow of the highest degree of accuracy.

1. Zone i, $-R$, $-R'$, i'

$i \wedge -R = 113° 12'$	$i \wedge -R' = 143° 48'$	$-R \wedge -R' =$	$149° 28'$
$i' \wedge -R' = 113° 10'$	$i' \wedge -R = 143° 45'$	$i \wedge i' =$	$77° 29'$

2. Zone i, R, R'', i'', $-R''$, $-R^{IV}$

$i \wedge i'' = 102° 8'$	$R \wedge R'' = 124° 2'$	$-R'' \wedge -R^{IV}$	$149° 13'$

Supposing for the moment that the two series of planes mentioned are true zones, and also that, as appears at first sight to be the case, the whole crystal is a complex *twin*, it is obvious that the twinning-plane for the two upper crystals of quartz must be a plane in the zone i, $-R$, etc., and must either halve the angle $i \wedge i'$, or which is the same thing $-R \wedge -R'$, or else be normal to this bisecting plane. Similarly, for either crystal above and the one diagonally below, the twinning-plane must also lie in the zone i, $+R$, etc., and must be either that plane which bisects the angle $i \wedge i''$, and $R \wedge R''$, or one at right angles to it.

For the first case the measured angle of $-R \wedge -R' = 149° 28'$, gives $38° 24'$, that is, $141° 36'$ or the angle between the twinning-plane and the prism i. Again, the measured angle $77° 29'$ for $i \wedge i'$ gives $38° 44\frac{1}{2}'$, that is, $141° 15\frac{1}{2}'$ for the inclination of the twinning-plane upon the prism i.

For the second case, the angle of $R \wedge R'' = 124° 2'$ gives $128° 53'$ for the angle between the prism and the twinning-plane, or $141° 7'$ if the twinning-plane is normal to the composition-plane. Again the angle of $i \wedge i'' = 102° 8'$ gives for the same angle $128° 56'$, or, on the other supposition, $141° 4'$. If we compare this angle ($141°$–$142°$) thus obtained with the inclination of the prism upon the successive planes of the zone between i and R having the general symbol m-$\frac{m}{m-1}$, we are surprised to find that it agrees quite closely with that which is required for $i \wedge 2$-2, viz. $142° 2'$. This plane 2-2, one of the most commonly occurring of all the various forms of quartz is thus *approximately the twinning-plane.* In the first case we obtained $141° 36'$ and $141° 15\frac{1}{2}'$, and in the second case $141° 7'$, and $141° 4'$. There is here some discrepancy, but considering the relation of the crystals the correspondence is very remarkable.

The conclusion to which we arrive then, is this: that although the position of the quartz is unquestionably determined by the

calcite, nevertheless the resulting form possesses a remarkably high degree of symmetry, and approximates very closely to that which would be produced by a twinning parallel to the plane 2-2. The two adjacent crystals are united by the twinning-plane, and the two diagonally opposite by a plane normal to this, but the same law of twinning applies to both cases.

It can hardly be questioned that this fact, that by this method of grouping the form of the quartz approximates so closely to a form which might well exist independently, must be at least a partial reason why it is here placed in so remarkable a geometrical relation with calcite.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Size of Hydrogen Atoms.*—Annaheim has described a simple lecture experiment in which the coloring power of fuchsin and cyanin is made use of to illustrate the extraordinary divisibility of matter. To form an idea of the amount of coloring matter visible to the naked eye, he weighed out 0·0007 gram fuchsin ($C_{20}H_{19}N_3HCl$)—a fragment about half a millimeter in diameter—dissolved it in alcohol and diluted the solution to a liter. In each centimeter, therefore, there was contained 0·0000007 gram coloring matter; and yet, placed in a burette one centimeter in diameter, the color showed distinctly even from a distance. A single drop of this solution—of 35 to the cubic centimeter—in a test-tube placed on white paper showed a distinct red color. Hence it follows that the eye can perceive ·00000002 gram fuchsin. But if we assume that each drop contains only one molecule, and it cannot contain less, then, since the molecular weight of fuchsin is 337·5, the maximum weight of a hydrogen atom is $\frac{1}{337\cdot5}$ of 0·00000002 gram, or 0·000000000059 gram! The same experiment with cyanin ($C_{28}H_{35}N_2I$) whose molecular weight is 526, leads to a similar result. One milligram dissolved in a liter of alcohol, will give for each drop 0·0000000285 gram. From this, it appears that the weight of the hydrogen atom cannot exceed 0·000000000054 gram, a curiously close coincidence.—*Ber. Berl. Chem. Ges.*, ix, 1151, September, 1876. G. F. B.

2. *On the Atomic Weight of Selenium.*—Pettersson and Ekman have made an extended research on the atomic weight of selenium, analyzing for this purpose calcium, magnesium and silver selenates, ammonium-aluminum selenate, silver selenite, and selenous oxide, all of the greatest attainable purity. Silver selenite on ignition yields a beautiful crystalline crust of pure silver. Hence by weighing the salt, igniting and again weighing, the data for determining the atomic weight are obtained. As a mean of seven analyses, the atomic weight obtained was 79·01. By

reduction of selenous acid by sulphurous acid, collecting and drying the precipitate and weighing it, another determination was made. The mean of five determinations, which agree well with each other, is 79·08. The authors, believing the latter determination to have more weight, assign the atomic weight 79·08 to selenium, which they believe correct to the first decimal place.—*Ber. Berl. Chem. Ges.*, ix, 1210, September, 1876. G. F. B.

3. *An improved Nitrogen-measuring Tube.*—ZULKOWSKY has improved the apparatus for measuring nitrogen by volume, which was proposed by Dumas. It consists of two tubes, 1·8 cm. diameter, and 58 cm. long, one of which is closed at the top, while both are drawn down at bottom so as to slip a rubber tube over the ends. The closed tube is graduated, and it, as well as the other tube, has a small lateral tube attached 44 cm. from the top, the one on the closed or measuring tube for connecting the apparatus with the combustion tube, the other furnished with a quetschhahn, for drawing off the liquid within. The two tubes are held parallel and upright and form a U tube. By turning the measuring tube down it may be filled with a potash solution. The combustion is proceeded with as usual, carbon dioxide evolved from hydro-sodium carbonate being used first to drive out the air. As the bubbles rise through the potassium hydrate, they are more and more perfectly absorbed. When this process is finished the substance is heated and the nitrogen is allowed to come over. Its temperature is noted, and, after making the level of the liquid the same in both tubes, its volume is read and reduced to the normal pressure and temperature. Analytical results obtained with it are given which are exceedingly accurate.—*Liebig's Ann.*, clxxxii, 296, September, 1876. G. F. B.

4. *On the Physical properties of Gallium.*—BOISBAUDRAN, having prepared a decigram of very nearly pure gallium, has made some careful observations on its physical properties. Its fusing point is about 29·5°, so that the heat of the hand liquefies it. When liquid, it exhibits the phenomena of surfusion to a remarkable degree. It has remained liquid for more than a month, the globule being frequently broken and reunited again by a steel blade, in a room the temperature of which often fell below the freezing point. Contact with a bit of solid gallium however, solidified it at once. Liquid gallium is very mobile, appears covered with a pellicle when exposed to the air, and adheres strongly to glass. Only a few degrees below its fusing point, the metal is hard and remarkably tenacious; but it may be cut with a knife as aluminum may. It crystallizes with facility, crystal facets being developed by treatment with hydrochloric acid. It does not oxidize at a red heat except upon the surface and it does not volatilize. Its spark spectrum gives the two well-known bright lines of wave length 417 and 403·1; its flame spectrum only the 417 line and this difficultly. Its density, approximately, is 4·7; thus placing it, like its other physical properties, between aluminum and indium. Its atomic weight places it there, probably, also.—*J. Phys.*, v, 277, September, 1876. G. F. B.

5. *New Vapor-density method for Substances of high Boiling-points.*—The labor consequent upon the determination of a vapor density in the case of a substance of high boiling point by the method of Deville and Troost, has led VICTOR MEYER to contrive a new method which is simple and easily applied, using no more material than the method of Hofmann and yet making determinations up to the boiling point of sulphur, 444·2°. In place of mercury, Wood's fusible metal, fusing at 70° C. is used. The principle involved consists in volatilizing a small but accurately weighed quantity of the substance in a vessel previously completely filled with the fusible metal, and then determining the volume of the vapor by heating in sulphur vapor and measuring the quantity of metal which has overflowed. The vessel employed is a bulb of about 25 c. c. capacity having a fine point at top and a tube 6 to 7 mm. diameter and 6·7 centimeters long issuing from the bottom and bent upward to just above the point. The author has determined as data, the specific gravity of the alloy at 444°, and its expansion coefficient between 98° and 444°; one gram at 98° increases 0·1092 c. c. at 444°. The substance is placed in a small tube, which it must completely fill, and is introduced into the bulb which is then completely filled with the metal, care being taken to exclude air-bubbles. After heating to the temperature of boiling water, the excess of metal on the tube is removed and the whole is weighed to decigrams. The bulb is then fastened to a wire, and the whole is plunged in the vapor of boiling sulphur till the temperature is uniform. It is then removed, allowed to cool partially and weighed. The difference in weight is the amount of overflow. Knowing the expansion-coefficient, its volume is easily calculated and reduced. All the data are now known, and in calculating the density the author uses the formula

$$D = \frac{S \cdot 14146000}{(a - 0{\cdot}036b)\,(P + \frac{2}{3}p)}$$

in which S is the weight of the substance used, a the weight of the metal used, b that which overflowed, P the barometric height, p the difference of level within and without. The density of diphenyl thus obtained is 5·33; cal. 5·32. Of anthracene 6·24; cal. 6·15. Of triphenylamine 8·49; cal. 8·48. Of anthraquinone 7·22; cal. 7·19. Of paradibrombenzene 8·14; cal. 8·15.—*Ber. Berl. Chem. Ges.*, ix, 1216, September, 1876. G. F. B.

6. *On Glycero-phosphoric acid from Brain Tissue.*—THUDICHUM and KINGZETT have described some of the salts of glycero-phosphoric acid obtained from kephalin, a substance prepared by the former from brain tissue. When boiled with baryta water, barium salts of certain fatty acids, barium glycero-phosphate, and one or two nitrogenous bases result. The lead, calcium and barium salts of glycero-phosphoric acid are described. A singular compound of the barium salt, called an alcoholo-hydrate, was obtained by precipitating it by alcohol, which contains probably three molecules of alcohol and six of water united to one of acid

glycero-phosphate. The authors give certain theoretical views concerning the kephalins, myelins and lecithins in the brain, all of which yield this acid.—*J. Chem. Soc.*, xxx, 20, July, 1876.

G. F. B.

7. *Chemistry: General, Medical, and Pharmaceutical, including the Chemistry of the U. S. Pharmacopœias. A manual of the general principles of the science, and their applications in medicine and pharmacy;* by JOHN ATTFIELD, Ph.D., F.C.S., etc. Seventh edition. Revised from the Sixth (English) edition by the Author. 668 pp. 12mo. Philadelphia, 1876. (H. C. Lea.)—Dr. Attfield's book has in nine years appeared in seven successive editions, of which the present has been adapted by the author expressly to the convenience of American students in medical chemistry. It is an excellent book in many respects, and evidently meets the wants of the class of students for whom it was prepared. The modern nomenclature and philosophy of chemistry and the metric system are used in the work.

B. S.

8. *A Systematic Hand-book of Volumetric Analysis, etc.;* by FRANCIS SUTTON, F.C.S., etc. Third edition. 438 pp. 8vo. Philadelphia, 1876. (Lindsay and Blakiston.)—The former editions of Mr. Sutton's excellent hand-book have long been in the hands of chemists. The second edition has for some time been out of print, however, and therefore the third edition is the more acceptable to working chemists who will find in it a careful digest of this department of chemical literature brought down to September, 1876. It bears marks of careful revision throughout. The sections on the analyses of potable waters and sewage have been completely revised and much enlarged by Mr. W. Thorp, long connected with the Pollution of Rivers Commission, as Chief Chemical Assistant under Drs. Frankland and Armstrong. The methods of analysis of potable waters introduced by these chemists are in this volume carefully collated from the original sources and presented in clear and exact statements. The chapters on gas analysis by Prof. McLeod have also been revised and extended. Under this head the author would have added to the value of his hand-book by introducing the eudiometrical apparatus described by Mr. C. W. Hinman in this Journal for September, 1874, (vol. viii, p. 182), which combines the good points of Russell and Williamson's, Doyère's, and Gibbs' apparatus with others of his own in a very compact form, giving accurate results with a very important saving of time and labor and the great convenience of enabling the chemists to conduct the analyses in any ordinary room. This book well deserves the highest commendation for its fullness, accuracy and systematic arrangement of the entire subject. It is a pleasure for once to see an American edition of an English science-manual escape the mutilation too frequently committed in the so-called "reprints from the last London edition."

B. S.

9. *Chemia Coartata, or the Key to Modern Chemistry;* by A. H. KOLLMYER, A.M., M.D., etc. iii pp. 12mo. Philadelphia. (Lindsay and Blakiston).—This is an attempt to present some of

the leading facts of chemistry in a tabular form. The facts are arranged in classified groups under the heads, Substance, Synonyms, History, Obtained form, Equations, Properties and Tests. "The main object of the author has been to compress into as small a space as possible everything connected with the study that deserves attention, and to give no more explanatory matter than is actually required to render each subject perfectly intelligible." It is evident from this statement that the author attempts too much for the beginner and accomplishes too little for the proficient student.

B. S.

10. *Lissajous' Curves.*—M. MERCADIER has introduced some improvements in the apparatus for producing these curves. Two large tuning forks are maintained in vibration by an electric current circulating around a magnet placed between the prongs. The pitch is regulated approximately by two weights of five or six hundred grams and a variation of an entire octave is thus attained. The main improvement is in the apparatus for varying the pitch by small amounts without stopping the forks. To one of the prongs is attached a small split nut through which a screw passes with a loaded head. The latter instead of being round has four projecting arms by means of which it may be turned with the finger or a small hammer. The distance of the center of gravity of the screw from the end of the fork is thus altered and with it the rapidity of the vibration. It is easy to see that the period of vibration increases with the amplitude, and although this change is very small, yet the optical method is so sensitive that it shows it clearly.—*Journal de Physique*, v, 309. E. C. P.

11. *Mechanical Equivalent of Heat.*—The committee of the British Association appointed to determine this constant, report progress as follows: Dr. Joule has been engaged in further measurements by means of the friction of water, and as the average result of sixty experiments gives 772·2 in British gravitation units at Manchester. The greatest deviation from the above average is $\frac{1}{200}$. Experiments have yet to be made on the capacity for heat of the calorimeter, the provisional computation being based on the experiments of Regnault. The greatest possible error from this source is probably $\frac{1}{300}$ and that from the incorrect boiling point of the thermometers $\frac{1}{400}$. The maximum value of these two corrections might amount to 4·5 in the above values. The experiments of Hirn on the friction of water have given him 786, but the average of his results from the friction, boring and crushing of metals gives 776. Assuming that the above experiments and those made by Dr. Joule for the committee on Standards of Electrical Resistance are to be relied on, the unit issued by it would appear to have a resistance one-fortieth too small. Inasmuch as the locality in which the experiments for that unit were conducted was open to objection, it appears desirable that they should be conducted under more favorable circumstances.—*Nature*, xiv, 476.

E. C. P.

12. *Ohm's Law.*—Prof. MAXWELL presented to the British Association at their last meeting the Report of the Committee for Testing Experimentally the Exactness of Ohm's Law. The prin-

cipal difficulty arises from the fact that the current generates heat, so that it is extremely difficult to keep the temperature constant with different currents. Since the resistance is the same whichever way the current passes, the resistance, if not constant, must depend upon even powers of the intensity of the current through each element of the conductor. Hence if we cause a current to pass in succession through two conductors of different sections, the deviations from Ohm's law will be greater in the conductor of smaller section, and if the resistances are equal for small currents they will be no longer equal for large currents. The first test was by means of five coils each of thirty ohms resistance, and two others to complete the bridge. A difference of over four-millionths in the relative resistance of any two of these coils proved to be measurable. According to Ohm's law, if either four of these were connected two and two, the resistance should be equal to that of the fifth coil. By mercury cups these were connected in such a way that each in turn could be compared with the other four. The results showed a small deviation from the law, probably due to irregularity in the conducting power of the connections since it was not confirmed in the more searching tests afterward applied.

A second method was next adopted in which weak and strong currents were alternately passed through two wires of nearly equal resistance but one short and fine the other coarse and long. The currents were changed thirty, and sometimes sixty times a second, so that the wire could not sensibly change in temperature in the interval. Since the current has far greater intensity in the fine than in the coarse wire the deviation should be correspondingly great. Combining these resistances with two coarse wires in a Wheatstone's bridge, if equilibrium occurred it must be due to either one of two causes. Either Ohm's law is true and there is no difference in the effect of the two currents, or the apparent equilibrium must arise from a succession of equal and alternate currents those in one direction due to the stout wire, those in the other to the fine wire. The latter case is easily tested by reversing the direction of the weaker current when its effect should add to that of the other. Currents are employed in some cases so powerful as to heat the finer wire to redness, but whenever the action was steady the reversal of the weaker current gave no result. Mr. Chrystal, by whom the experiments were performed, has put his result in the following form: If a conductor of iron, platinum or German silver of one square centimeter in section has a resistance of one ohm for infinitely small currents, its resistance when acted on by an electromotive force of one volt (provided its temperature is kept the same) is not altered by so much as the millionth of the millionth part.

It is seldom, if ever, that so searching a test has been applied to a law which was originally established by experimeut, and which must still be considered a purely empirical law, as it has not hitherto been deduced from the fundamental principles of dynamics.

But the mode in which it has borne this test not only warrants our entire reliance on its accuracy within the limits of ordinary experimental work, but encourages us to believe that the simplicity of an empirical law may sometimes be an argument for its exactness, even when we are not able to show that the law is a consequence of elementary dynamical principles.—*Nature*, xiv, 452. E. C. P.

13. *Protection of Buildings from Lightning.*—Prof. MAXWELL suggests another system of protecting buildings quite unlike that in common use. Attention is generally especially devoted to the two ends of the conductor, to secure an elevated and pointed terminal above and a good connection with moist earth below. This system seems calculated rather for the benefit of the surrounding country and for the relief of clouds laboring under an accumulation of electricity, than for the protection of the building on which the conductor is erected. What we really wish is to prevent the possibility of an electric discharge taking place within a certain region, say in the inside of a gunpowder manufactory. An electric discharge cannot occur between two bodies unless the difference in their potentials is sufficiently great compared with the distance between them. This may be avoided by connecting all these bodies by good conductors as wire ropes. But this is not necessary if the exterior is covered with a good conductor. Thus, if the roof, walls and ground floor are covered with thick sheet-copper, no electrical effect could be produced inside by a thunder storm. No earth connection would be necessary and the building might even be insulated by a layer of asphalte. Any long conductor, as the gas or water pipes, should be connected with the sheet copper. Accordingly a telegraph wire should not pass inside the building, since this connection would render it useless. An entire covering is by no means necessary. A network formed by carrying a stout copper wire around the foundation, up each of the corners and gables and along the ridges would probably be sufficient for any thunderstorm in this climate. If there are any gas or water pipes, they should be connected with the wires, but if there are no such metallic connections with distant points, it is not necessary to take any pains to facilitate the escape of the electricity into the earth.—*Nature*, xiv, 479. E. C. P.

14. *On the Tidal Retardation Argument for the Age of the Earth.*—Mr. JAMES CROLL, LL.D., F.R.S., of the Geological Survey, read a paper "On the Tidal Retardation Argument for the Age of the Earth." Many years ago Sir William Thomson demonstrated from physical considerations that the views which then prevailed in regard to geological time and the age of our globe were perfectly erroneous. His two main arguments, as are well known, were—first, that based on the sun's possible age; and secondly, that based on the secular cooling of the earth. More recently he has advanced a third argument (Trans. Geol. Soc. of Glasgow, vol. iii, p. 1), based on tidal retardation. It is well known that owing to tidal retardation the rate of the earth's rotation is slowly diminishing, and it is, therefore, evident that if we

go back for many millions of years we reach a period when the earth must have been rotating much faster than now. Sir William's argument is, that had the earth solidified several hundred millions of years ago the flattening at the poles and the bulging at the equator would have been much greater than we find them to be. Therefore, because the earth is so little flattened it must have been rotating, when it became solid, at very nearly the same rate as at present. And as the rate of rotation is becoming slower and slower, it cannot be so many millions of years back since solidification took place. A few years ago I ventured to point out (*Nature*, Aug. 21st, 1871; Climate and Time, p. 335,) what appeared to be a very obvious objection to the argument, and as the validity of the objection, so far as I am aware, has never been questioned, I have been induced to believe that the argument referred to had been abandoned. But I find that Professor Tait in his work on "Recent Advances in Physical Science," restates the argument as perfectly conclusive, and makes no reference whatever to my objection. As the subject is one of very considerable importance, I may be permitted to direct attention to the objection in question, which briefly is as follows:

It has been proved by a method pointed out a few years ago (Philosophical Magazine, May, 1868, pp. 378–384, February, 1867, p. 1830; Climate and Time, Chap. xx; Transactions of Geological Society of Glasgow, vol. iii, p. 153), and which is now generally admitted to be reliable, that the rocky surface of our globe is being lowered, on an average, by subaerial denudation at the rate of about one foot in 6,000 years. It follows as a consequence from the loss of centrifugal force resulting from the retardation of the earth's rotation, occasioned by the friction of the tidal-wave, that the sea-level must be slowly sinking at the equator, and rising at the poles. This, of course, tends to protect the polar regions, and expose equatorial regions to subaerial denudation. Now, it is perfectly obvious that, unless the sea-level at the equator has, in consequence of tidal retardation, been sinking during past ages at a greater rate than one foot in 6,000 years, it is physically impossible that the form of our globe could have been very much different from what it is at present, whatever may have been its form when it consolidated; because subaerial denudation would have lowered the equator as rapidly as the sea sank. But in equatorial regions the rate of denudation is, no doubt, much greater than in the temperate regions. It has been shown in the papers above referred to that the rate at which a country is being lowered by subaerial denudation, is mainly determined, not so much by the character of its rocks, as by the sedimentary carrying power of its river systems. Consequently, other things being equal, the greater the rain-fall the greater will be the rate of denudation. We know that the basin of the Ganges for example is being lowered by denudation at the rate of about one foot in 2,300 years, and this is probably not very far from the average rate at which the equatorial regions are being denuded. It is therefore evident that subaerial denudation is lowering the equator as

rapidly as the sea level is sinking from loss of rotation, and that consequently we cannot infer from the present form of our globe what was its form when it solidified. In as far as tidal retardation can show to the contrary its form may have been as oblate as that of the planet Jupiter when solidification took place.

There is another circumstance which must be taken into account. The lowering of the equator by the transference of materials from the equator to the higher latitudes must tend to increase the rate of rotation, or, more properly, it must tend to lessen the rate of tidal retardation.

15. *Sound*, by JOHN TYNDALL. 448 pp. 8vo. Third edition, revised and enlarged. New York. 1876. (D. Appleton & Co.) —The Preface to the new edition of this valuable work opens with the statement of the author that in preparing this new edition of his work he has amended, as far as possible, its defects of style and matter, and paid at the same time respectful attention to the criticisms and suggestions which the former editions called forth. The most important new matter introduced is an account of the author's investigations on the acoustic transparency of the atmosphere in relation to Fog-signaling. The preface contains an account of work done in the same line in America, and especially by Prof. Henry, after which follow arguments against Prof. Henry's explanation of the observed phenomena. The distinguished author repeats in his preface his former remarks on the "injurious influence still exercised by authority in science," that it is "not only injurious but deadly when it cows the intellect;" when if any one's intellect has been thus cowed in this free age, no one is to be blamed but himself.

16. *Entwickelung der theoretischen Ansichten über die gepaarten Schwefelverbindungen von* GEORGE A. SMYTH (of Amherst, Mass.) 122 pp. 8vo. Berlin. 1876.

II. GEOLOGY AND MINERALOGY.

1. *Report on the Geological Map of Massachusetts, prepared by* W. O. CROSBY, Assistant in the Laboratory of the Boston Society of Natural History. 52 pp. 8vo. Boston. 1876.—The map here referred to is one colored for the Centennial Exposition at Philadelphia. Mr. Crosby lays down the distribution of Norian, Huronian, Mont-Alban, and Paleozoic areas in the State, gives an account of the rocks, characterizing them, stating briefly their kinds and their supposed stratigraphical relations. Of the rocks of the State, the remark is made at the outset, that they "are mainly crystallines, which are believed to belong wholly to the Eozoic [Archæan] era;" but no satisfactory evidence on this question of age is brought forward except that with regard to the formation underlying unconformably the Primordial of Braintree. The fossiliferous limestone of Bernardston, containing large crinoidal stems, and referred by Hall, Billings and others to the Helderberg formation (lower or upper), and which underlies mica slate and quartzyte, seems to be included by the author with the Mont-

Alban, the statement being made that the argillite of Bernardston is of this age; if not so intended, this most interesting formation is left unnoticed. Of the age of the limestone and associated rocks in Berkshire, Mr. Crosby says: "it seems probable that it will ultimately prove to be, as an increasing number of geologists are inclined even now to regard it, older than the Primordial." Such a conclusion is at variance with the fact of the existence of Lower Silurian fossils at some Vermont localities in the limestone. The pamphlet closes with an account of the Geology of the Nashua Valley, by L. S. Burbank.

2. *Geological Survey of Indiana; Seventh Annual Report on the Surveys made during the year* 1875, E. T. Cox, State Geologist. 302 pp. 8vo.—This Report treats of the special geology of Vigo and Huntington counties, by Mr. Cox; of Riply and Jennings counties, by W. W. Borden; of Orange, by M. N. Elrod and E. S. McIntire; of Vanderburg, Owen and Montgomery counties, and portions of Clay and Putnam counties, by J. Collett; and contains also a report on the depth and temperature of the lakes of Northern Indiana, by G. M. Levette, and another on the Flora of the Wabash Valley, by J. Schenck, M.D., and on Fossil marine plants of the Carboniferous, by L. Lesquereux. The volume commences with a General Report by the head of the Survey, which includes a review of the principal observations of the year, together with information on the Coals of the State, with the results of numerous analyses, on the distribution of the millstone grit and on its whet-stone bed in Orange Co., with a list of the fossil plants in this bed, as furnished by Prof. Lesquereux.

Mr. Levette's survey of the Lakes states that the ancient shores of many of the lakes afford a chalky material, which is nearly pure carbonate of calcium (with 3 or 4 per cent of magnesia), the beds of which are in some places 20 or 30 feet thick. It affords no evidence of organic origin, and hence is stated to be probably a chemical deposit. An *artesian boring* at Fort Wayne has reached a depth of 3,000 feet; the first 88 feet were of drift; and then it entered a Niagara limestone, and continued through limestone and calcareous shale to 2,500 feet; thence, through soft calcareous rock to its present bottom in the Lower Silurian. The temperature at 90, 100, 1,000, 1,500 and 2,635 feet, registered by the thermometer was 51½° F. Another well at Wabash commenced in the Niagara limestone and was continued in limestone and calcareous shale to a depth of 2,270 feet, without getting a flow of water. At 100, 500, 1,000, and 2,270 feet the temperature of the water obtained was 50½° F. The thermometer was one made for the purpose by James Green of New York. Mr. Cox says that "The inference to be drawn from the uniform temperature of these wells is that they are filled with water that comes from an upper stratum." In another well 1,923½ feet deep at Terre Haute, penetrating the Coal measures and Devonian, and stopping, it is believed, in the Niagara, the temperature obtained throughout was 81° F.; and this is referred to waters from the lower part of the well filling it.

3. *Geological Map of Scotland*, by ARCHIBALD GEIKIE, Director of the Geological Survey of Scotland. Edinburgh. (W. & A. K. Johnston, Geographers and Engravers to the Queen).—Professor Geikie has contributed much by his own labors to the knowledge of Scottish geology, and thereby, aided also by the labors of others on the survey and of independent investigations, he has been enabled to make great improvements in preparing this new edition of the map. It is well colored, and presents to the eye illustrations of various problems of great interest to general geology. It is of convenient portable size, measuring about one foot ten inches by two feet ten.

4. *Huronian of Canada.* Letter from Mr. A. R. C. SELWYN, Director of the Geological Survey of Canada, to J. D. Dana, dated Montreal, October 28th, 1876.—Referring to Article XXXVI in the October number of your Journal, it seems to me that Mr. Bradley has quite misunderstood what I wrote him respecting the so-called Huronian Series of Canada. I am not aware that I ever mentioned Sir William Logan's name to Mr. Bradley, in the matter; and certainly if Sir William held the views attributed to him, he never informed me of the fact. When Mr. Bradley sent me a copy of his map, in acknowledging the receipt of it I remarked that I could not agree in the propriety of including the whole of the Huronian Series in the Silurian System, though I saw no reason for supposing it to be older than the Cambrian—Harlech and Longmynd rocks—of the British Survey, which are supposed to occupy a position between the Primordial and the Laurentian, which is also the position assigned to the Huronian series in America. I informed Mr. Bradley that the Mistassinni Lake Huronian band was, in some part of its course, from 150 to 200 miles wide, (not 300 miles as stated), and that in mineral character part of it very closely resembled the altered Quebec group of Canada, notably in the chromiferous serpentine, magnetite and dolomite. If, however, it is an established fact that in Minnesota and Wisconsin the same Huronian rocks are unconformably covered by the Potsdam sandstone it becomes certain, whatever their mineralogical resemblances may be, that they cannot belong to the Quebec group, and we have not, so far as I know at present, any evidence which would warrant us in classing them with the Silurian.

5. *Geological Survey of Michigan. Fossil Corals, by* Dr. C. ROMINGER, *State Geologist.* 154 pp. 8vo, with 55 plates.—An "advance copy, unrevised by the author," has been received, and it gives us great pleasure to announce the appearance of a work that will so largely meet the necessities of American paleontological science in the department of Fossil Corals. The illustrations are albertypes, and beautiful specimens of the art, being among the best from the engraving office of Julius Bien of New York. The science of the country owes much to the Geological Board of the State of Michigan, that they authorized the preparation and publication of so complete and well-illustrated a Report on this hitherto much neglected branch of American Paleontology.

6. *Memoirs of the Geological Survey of India. Palæontologica Indica.*—Published by order of the Governor General of India in Council, under the direction of Thomas Oldham, LL.D., Superintendent of the Geological Survey of India. Vol. i, Parts 2, 3 and 4 (1875), contain the continuation of the memoir on the Jurassic Ammonitidæ of Kutch, by William Waagen, Ph.D. They include plates 5 to 60, and finish the volume.

The *Memoirs of the Survey* in octavo, vol. xi, part 2 (226 pages), contain, a paper of 226 pages by Mr. Wynne, on the *Trans-Indus Salt region*, Kohat District, which is illustrated by several fine plates, showing the displaced and folded character of the rocks. The folds, which are often of great complexity, include the Nummulitic and other Tertiary beds. The Rock Salt belongs to the lower part of the Nummulitic strata, and is referred to the early Eocene. In some places, and especially near Bahádur Khél, the salt forms high detached hills, cliffs, and naked exposures for a distance of four miles, with a width exceeding a quarter of a mile; and to the eastward for four miles, there are large crater-like holes, proving its presence now or formerly beneath the surface. Throughout the district it frequently appears in precipitous outcrops within the elliptical boundaries of the Nummulitic limestone. The salt is, for the most part, remarkably pure, without admixture with potash salts. The maximum thickness of the salt rock is not less than 1,230 feet. It is associated with gypsum, and to the eastward is somewhat bituminous at top. The underlying strata are not known; and the absence of fossils from the salt beds leave some doubt as to its precise age. A large colored geological map accompanies the memoir.

The *Records of the Geological Survey*, vol. ix, part 1, 1876, contain a brief Annual Report, together with an account of the Geology of Sind, by Wm. T. Blanford, the rocks of which, thus far observed, range from the Infra-nummulitic, supposed to be Lower Eocene to the Pliocene and more recent.

7. *Detritus of Rivers.*—The Liverpool Geological Society held its first annual meeting of the session on the 10th instant, when the retiring president, Mr. T. Mellard Reade, C.E., F.G.S., delivered his annual address. The subject was an interesting one, being a calculation of the amount of solid matter removed annually from the surface of England and Wales in solution, in rain, or rather river water. The result of the calculations, which were of an elaborate nature, founded upon the analysis of water given by the Rivers' Pollution Commission in their Sixth Report, and the rainfall chart prepared by Mr. Symons, showed that it would take 13,000 years to remove, in this manner, one foot in depth of solid matter over the entire surface of England and Wales. This calculation was compared with others prepared by Mr. Reade, of the soluble denudation of the great river basins of Europe, viz: the Danube, the Rhine, and the Rhone. As throwing light upon the age of sedimentary deposits, the calculations taken, together with the amount of matter annually brought down in river water

in suspension in the form of mud, are extremely interesting, and Mr. Reade deduced from them that the minimum amount of time which must have elapsed since the first sedimentary rocks we know of were laid down is, in round numbers, 500 millions of years, thus supporting the views of Lyell, Hutton, and other great geologists, as to the immense age of the world.—*Nature*, Oct. 26.

8. *Mallet's Theory of Volcanic Energy.*—The paper of Prof. Mallet upon volcanic energy, which was translated into German by Prof. A. von Lasaulx, has been somewhat severely criticized in the Göttingen Gelehrte Anzeige by O. Lang. This criticism has recently been fully answered by Prof. Lasaulx. He gives a satisfactory demonstration of the mathematical formula referred to $\left(T = \frac{P\rho}{2}\right)$, that by which Mallet proves that a crushing of the materials of the earth's crust must take place, and shows that it is mathematically complete. Moreover, he convicts Mr. Lang of a total misunderstanding of the question involved, and shows that he himself is alone responsible for the difficulties which he suggests.

9. *Geological reunion at the Paris Exposition in* 1878.—The American Association for the Advancement of Science, at its session on the 25th of August last, unanimously adopted the following resolution:—

Resolved, That a Committee of the Association be appointed by the Chair to consider the propriety of holding an International Congress of Geologists at Paris, during the International Exhibition in 1878, for the purpose of getting together comparative collections, maps and sections, and for the settling of many obscure points relating to geological classification and nomenclature. And that to this Committee be added our guests, Prof. T. H. Huxley of England, Dr. Otto Torell of Sweden, and Dr. E. H. von Baumhauer of the Netherlands, who shall be requested to open negotiations in Europe looking to a full representation of European geologists at the proposed Congress. The said Committee to consist of Prof. William B. Rogers, Messrs. James Hall, J. W. Dawson, J. S. Newberry, T. Sterry Hunt, C. H. Hitchcock and R. Pumpelly, in behalf of the Association, with the addition of Prof. T. H. Huxley, Dr. Otto Torell and Dr. E. H. von Baumhauer.

On the same day, at a meeting of the Committee, Prof. James Hall was elected Chairman, and Dr. T. Sterry Hunt, Secretary. A circular has since been issued, which is to appear in English, French and German, and to be distributed to geologists throughout the world, asking their coöperation in this great work of an International Geological Exhibition and an International Geological Congress to be held at Paris in 1878; the precise date of the Congress to be subsequently fixed.

This circular recommends with reference to the objects of the Congress, that the Geological department of the Exposition shall embrace: (1) Collections of rocks, illustrating all points of lithological and geological interest; (2) of fossils, and especially of the Primordial or Cambrian; and (3) of geological maps and sections.

10. *Recent Discoveries of the Brazilian Geological Commission;* by THEO. B. COMSTOCK, Assistant Professor in charge of Geological Department, Cornell University.—The Rio Curupatúba enters the Amazonas from the north at a distance of four hundred miles from the Atlantic coast. A few miles above the confluence of these rivers, on the left bank of the former, is situated the villa of Monte Alegre. From this point, in 1870, while acting as an assistant on the first Morgan expedition from Cornell University, the writer made a trip northwestward across the country over the trail leading to the hamlet of Ereré.* Messrs. Herbert H. Smith and Phineas P. Staunton were of the party. Shortly after crossing the Igarapé de Ereré, a small river which communicates with the Curupatúba through the lower portion of the Igarapé do Paitúna, we discovered an exposure of Devonian shales yielding a few fossils, afterward identified by Mr. Richard Rathbun. He found them to be related to species characteristic of the Hamilton Period in New York State, one being only a variety of *Discina Lodensis* Hall, while the others were new species of the genus *Lingula*.† In his review of the geology of this region, Professor Hartt remarks:‡ "The great repository of fossils is the sandstone, which . . . . . appears to form bands a few inches in thickness, interstratified with the shales in their upper part. [N. B.—These shales are probably not the equivalents of those previously mentioned, for they are exposed two miles north of the little village of Ereré.—T. B. C.] . . . . ." "The fossils most abundant in the sandstone are the Brachiopoda, which are represented by twenty species belonging to the following genera: *Terebratula*, *Vitulina*, *Tropidoleptus*, *Spirifera*, *Cyrtina*(?), *Retzia*, *Streptorhynchus*, *Chonetes*, *Orthis*, *Rhynchonella* and *Lingula*, all of which are described in the paper of Mr. Rathbun."

The structural geology of the Ereré-Monte Alegre district was studied with considerable care by Professor Hartt and his assistants on the first Morgan expedition, and further details were determined by himself and Mr. O. A. Derby in the following year (1871). They were unable, however, wholly to unravel some of the more difficult problems presented in that region, for which reason Messrs. Derby, Smith and Freitas, of the Brazilian Geological Commission, have spent the past few months in a thorough survey of the whole area. The importance of the results obtained by them, as reported in a recent letter from Mr. Derby, will be better understood after a brief review of the general physiognomy of the district under consideration.

The villa of Monte Alegre (upper town) is perched upon the top of a comparatively level block of horizontal Tertiary beds,

* See Preliminary Report on the Geology and Physical Geography of the Ereré-Monte Alegre District, by Professor Ch. Fred. Hartt, in charge of the expedition, in Bulletin of the Buffalo Soc. Nat. Sci., January, 1874.

† *L. Graçana* Rathbun, and *L. Stauntoniana* Rathbun, figured and described in his paper "On the Devonian Brachiopoda of Ereré, Province of Pará, Brazil, in Bull. Buffalo Soc. Nat. Sci., January, 1874, p. 259.

‡ Ibid., p. 212.

extending in a curved line to the north and the east. To the southward stretch the broad alluvial Amazonian plains, across which the Curupatúba has cut its way, and through a part of which the lower portion of the Igarapés of Ereré and Paitúna are now flowing. The upper portion of the Igarapé de Ereré and its little tributaries together drain the nearly square Devonian floor, at the southern side of which is situated the Indian village of Ereré. The rocks over the last mentioned area are horizontal or but little inclined, but the square space is partially enclosed by bold *serras* of more complicated structure and of other formations. A series of ridges extending across the southern limit of the plain comprises the serras of Ereré; Aroxi and Aracuré, the western edge is bounded by ranges of low hills; the serra of Tanajurí occupies the eastern end of a row of ridges along the northern side, and the Monte Alegre plateau completes the enclosure. The serra do Paitúna lies off by itself a few miles beyond the southern boundary of the square.

The table-topped hills between Prainha and Almeirim (Serras de Parú), noticed in nearly every account of Amazonian travel, were never examined carefully until Professor Hartt visited them in 1871.* They lie much farther to the east, down the Amazonas from Monte Alegre, and have generally been regarded by travelers as members of the same system of *serras* as the ridges of Ereré, Paitúna and Tanajurí. This view was shown to be erroneous by Hartt,† who examined the westernmost one of this series, known as the serra Parauaquára, and found it to be made up of horizontal strata probably of Tertiary age.

Messrs. Derby and Smith, with Senhor Freitas have now succeeded in resolving the equivalents of the formations outcropping over the Ereré-Tanajurí district, with results of great interest to science. They have discovered a few localities rich in fossils, such being quite uncommon in this tropical region where exposures are few and the rocks very much weathered. The serras, in which the rocks are much contorted, are composed largely of Cretaceous beds extending downward into the upper Paleozoic formations, Carboniferous and Devonian. North of Ereré, they discovered 1000 feet or more of Lower Devonian rocks, underlying those found by Mr. Smith and the writer in 1870. These new beds are mainly *parachronous*‡ with the Oriskany sandstone of North America. Mr. Derby writes that he has obtained from this horizon "seventy-five species, including several characteristic Oriskany species, mixed with true Devonian forms. The Oriskany here is certainly Devonian." This discovery seems very significant in its bearing upon certain theories in connection with "cycles of deposition." An apparent conflict in geognostical and paleontological

* Von Martius, in fact, was the only previous visitor to the serras. He reported (*Reise in Brasilien, IIIer Theil., S.* 1326), upon the botany of one of the Serras de Almeirim, but barely touches its geology.

† Bull. Buff. Soc. N. S., ibid., p. 228, *et seq.*

‡ The term *parachronous* was suggested by the writer (Reconn. N. W. Wyoming, etc., Jones, 1874, p. 143) as convenient to apply to beds of the same *relative* age, when true *synchronism* is uncertain.

records is thus harmonized, as it appears. The same number of species is reported from the Upper Devonian of the Ereré district, and the Carboniferous beds have yielded a similar number to Mr. H. H. Smith, among which there are probably some entirely new forms. The latter formation appears to extend widely over South America, as elsewhere. The fossils identified by Mr. Derby, which were collected on the Morgan expeditions, came from outcrops in the vicinity of Itaitúba, on the Rio Tapajos,* and these were regarded by him as closely related to the Bolivian Carboniferous fauna and to other beds of similar age (Coal measures) in both North and South America and in Europe.† The Cretaceous beds of the serras have afforded many fossils, in places, but no details are furnished by the members of the Imperial Survey.

Professor Hartt, at latest account, was engaged in a personal exploration of the Coal-Measure area in the southern province of Santa Catharina, where characteristic plant-fossils and workable beds of coal are known to exist.‡ The occurrence of coal in the valley of the Amazonas has been suspected; there is probably no region in the world where it could be more advantageously employed, but as yet no exposure of valuable beds has been reported.

11. New Minerals. *Mottramite, Roscoelite.*—Prof. H. E. Roscoe has recently described a new vanadium mineral, under the name of *Mottramite.* It occurs as a crystalline incrustation on the Keuper sandstone at Alderley Edge, and at Mottram St. Andrew's, Cheshire, England. The incrustation is usually thin, but sometimes 3 or 4 mm. in thickness. Occasionally in minute crystals of a black velvety appearance in the mass, but by transmitted light yellow. Also compact, opaque, and of a purplish brown color. Luster resinous. Streak yellow. H.=3; G.=5·894. The mean of two analyses gave V_2O_5 17·14, PbO 50·97, CuO 19·10, (Fe, Zn, Mn)O 2·52, CaO 2·13, MgO 0·26, H_2O 3·63, moisture 0·22, silica 1·06=97.03. The formula is written $(PbCu)_3V_2O_8 + 2H_2(PbCu)O_2$ analogous to erinite and dihydrite.

Prof. Roscoe has also examined the *roscoelite*, named by Dr. Blake, and since described by Dr. Genth (see this Journal, III, xii, 31, 32). The formula to which his analysis leads is as follows:—$2AlV_2O_8 + K_4Si_9O_{20} + aq.$; this is quite a different result from that obtained by Dr. Genth.—*Proc. Roy. Soc.*, June 15, 1876.

12. *The "Mexican Onyx."*—Prof. Marianor Bacena, of the Mexican Commission to the Centennial Exposition, has recently published an account of the occurrence and chemical character of the rocks called *Mexican onyx.* The principal deposits are located near the town of Tecalli, in the State of Puebla. It is essentially a carbonate of calcium, containing small quantities of the oxides

* A tributary of the Amazonas, entering the latter from the southwest at Santarem, not many miles above Monte Alegre.

† See paper "On the Carboniferous Brachiopoda of Itaitúba, Rio Tapajos, Province of Pará, Brazil," by O. A. Derby, Bull. Cornell University, (Science), Vol. I, No. 2, where figures and descriptions are given.

‡ Hartt, Geology and Physical Geography of Brazil, 1870, p. 519.

of iron and manganese, to which the variegated colors are due, for which the rock is so much admired. The specific gravity, 2·9, shows that it is aragonite.

III. Botany and Zoology.

1. *Relation of Coloration to Environment.*—Mr. Wallace's oversight about a "*Pelargonium* of Kerguelen's Land," has been pointed out in *Nature* and noted in this Journal (p. 400). There is another oversight as to locality, which may as well be corrected, though of no practical consequence. It is in Florida, not "Virginia," that the white pigs are poisoned by Paint-root (*Lachnanthes*), while the black are unaffected. It may be, however, that Mr. Darwin's explanation of the immunity is nearer the mark than Dr. Ogle's, adopted by Mr. Wallace, plausible as the latter is. For if only black hogs are raised, as Prof. Wyman stated, and if the black pigs, by reason of better smell and taste do not eat the root, as Dr. Ogle suggests, what is it "which colored their bones pink?" It may not be so, but Prof. Wyman's account implies that the bones of the black hogs are thus colored. Will some one at the proper localities in Florida investigate this? A. G.

2. *Subradical solitary Flowers in Scirpus.*—The Rev. Thomas Morong, of Melrose, Massachusetts, recently brought me some specimens of my *Scirpus supinus*, var. *Hallii* (olim *S. Hallii*), which he gathered on the borders of Winter Pond in Woburn or Winchester, Massachusetts, late in September. Mr. Wm. Boott had also detected this plant in the same locality. It is interesting to know that this is a New England as well as a Western species. But a higher interest is given by Mr. Morong's discovery that this plant freely produces solitary female flowers in the axils of sheaths or short leaves at the base of the culm. These subradical flowers, apparently produced only at the close of summer, have capillary styles of half an inch to a full inch in length, mostly deeply three-cleft with unequal branches, sometimes three-parted or two-parted nearly to the ovary. The latter sometimes matures an akene which is similar to those of the spikes above. No stamens have been detected in these flowers; but they are found in some imperfect and four to five-flowered subradical spikes which I have occasionally met with, and which are in some sort intermediate between the ordinary and this extraordinary inflorescence. Mr. Morong noticed that the flowers in his specimens were triandrous; but I find that some are diandrous. These long-overlooked subradical flowers are now obvious in most of my herbarium specimens from Illinois, Missouri, and Texas, in those with trifid as well as those with bifid stigmas of the ordinary flowers. I find no trace of subradical flowers in the true *S. supinus* of the Old World, but my specimens are scanty. They occur, however, in a specimen (resembling our American plant) of Griffith's Bengal collection. This American variety, or species, has narrower spikelets and more carinate scales than is usual in *S. supinus*.

A. G.

3. *Dictionaire de Botanique;* par M. H. BAILLON. *Dessins* de A. FAGUET. Premier fascicule. (5 francs.) Paris: Librairie Hachette & Cie.—This is a large undertaking. The first fasciculus just issued consists of 80 pages, large 4to, double columns, with one chromolithic colored plate (of an *Æschynanthus*) and very many wood-cuts, some of which have done service in the editor's other works. To this we would not object, nor to the more profuse than pertinent illustration of the first article of the book, viz: a privative, by sixteen figures, five to explain its use in the word *acetylédone*, three for that of *asépale*, six for *apétale;* but we do object to the teaching that *Rubia*, *Loranthus* and *Thesium* are destitute of calyx, and that *Asparagus*, *Frittillaria* and *Galanthus* are apetalous. The work is almost exhaustive in plan, is beautifully illustrated, and well printed on excellent paper. The price therefore is low; for those who do not possess a botanical library it should be a boon; for those who do, a great convenience. It is far more needed than the *Histoire des Plantes*, and we are glad that Prof. Baillon has turned his labors in this direction. The list of collaborators already announced, and who have contributed to this fascicle contains good names, the more notable being those of De Seynes, Nylander, Fournier, Bureau, Weddel and Ascherson. Among them is the name of *Rafinesque!* Apparently all botanical names are to be given, the genera in French or Latin form, or in both, generic characters sketched, important genera illustrated, popular names explained or referred, botanical terms defined, and botanical authors biographically noticed. The physiological articles are encyclopœdic; that on *absorption* fills almost six of the large pages, *accroisement* four and a half. Accuracy in such a work is of the first importance, and we may presume that all reasonable pains will be taken. But we notice that, on p. 27, the akene of a Valerian, with its pappus, figures for that of a *composée*, and on p. 41, *Trautvetteria* is named *Actæa spicata*, and Agassiz is said to have died at New York. A. G.

4. *Nuovo Giornale Botanico Italiano* diretto du T. CARUEL. Pisa. Vol. viii. 1876.—This volume was issued in four parts, of unequal size, the first in January, the fourth in October; the journal is apparently well sustained; and, besides the editor's own articles, has papers by De Notaris, Delpino, Arcangeli, Saccardo, etc. A. G.

5. *Flora Orientalis . . . auctore* EDMOND BOISSIER.—The third volume of this important Flora—which failed to reach us seasonably—was published in 1875. It fills 1133 pages, and carries the work on from *Caprifoliaceæ* to *Pyrolaceæ* inclusive; the larger part being occupied by the *Compositæ*, which dominate in the Orient as they do in North America, but under different tribes, the *Inuleæ* and *Cynareæ* taking the lead. *Centaurea* has 182 species, *Cirsium* (*Cnicus*) 74, and *Cousinia* 136, almost all Asiatic. Before the close of 1875 the first part of the fourth volume was likewise issued (280 pages), continuing the *Gamopetalæ*, *Borragineæ* being the largest order. The remainder of this volume may soon be expected. A. G.

6. *On the Barringtoniaceæ*, by JOHN MIERS, F.R.S., etc.—An elaborate memoir of this group of tropical plants, published in the first volume of the new series of the Transactions of the Linnean Society, London, 1875, with nine plates. Mr. Miers insists upon the complete separation of these plants from *Myrtaceæ*, and their independence as a natural order, of ten genera, one of which is a restoration and four newly proposed. The typical genus is reduced to a single species, while the restored *Butonica* has sixteen, and *Stravadium* nineteen. It is interesting to see that a veteran of the author's age has the courage to undertake and the force to execute a work of this sort. The figures, moreover, are all by his hand. A. G.

7. *A Catalogue of the Forest Trees of the United States, which usually attain a height of sixteen feet or more, with notes and brief descriptions of the more important species, illustrating the collection of Forest-tree sections on exhibition by the Department of Agriculture at the Centennial Exhibition, Philadelphia.* Prepared by GEO. VASEY, M.D. (Washington, 1876. 38 pp. 8vo.)—All agree in awarding great credit to Dr. Vasey for the United States exhibition of our native trees and arborescent plants. Making the collection general and as far as possible complete, and stinted both in means and time, he could not undertake to accumulate sections of large trunks, such as those of some State and other exhibits; but his collection was full, systematic, well-displayed, and most instructive. This accompanying pamphlet, very useful in illustrating the exhibition, will still be convenient and valuable for reference. A. G.

8. *Morphology of the Carpellary Scales of Coniferæ.*—The true nature of the female flower of Coniferæ has been an important question among botanists since fifty years, when Robert Brown first announced the doctrine of their gymnospermous character. Without going into details of the history of investigations and theories, it may be stated at once that the very thorough treatment of the question by G. Stenzel, published a few months ago in the Nov. Act. Nat. Cur., vol. xxxviii, as reported by Prof. Eichler in Flora of September 1st, seems definitely to settle the controversy. The result of Stenzel's examination of numerous monstrosities of female flowers of the *Abies excelsa*, obtained at the limit of tree vegetation on the Sudetic Mountains, is that Mohl's view of the structure of the fruit-scale, based on the nature of the double leaf of Sciadopitys, is the correct one. The fruit-scale in *Abies*, and in all *Abietineæ*, in this view consists of two leaves of an undeveloped axis, or branchlet originating in the axil of the bract, and the posterior (superior) edges of these leaves being connate laterally and a little backward, as the lowest pair of leaves or bracts in Coniferæ always are, the leaves turn their back toward the axis of the inflorescence (the cone) and bear on that side one ovule each. In *Cupressineæ*, where the carpellary scale is peltate, and often bears numerous ovules, the same morphological explanation holds good, and even in *Podocarpeæ*

and *Taxineæ*, which have no fruit-scale, we must come to the same conclusion, assuming a virtual suppression of the scale. The greatest difficulty seems to arise from the position of the ovules on the dorsal side of the open carpel, which is not seen in any angiospermous plants; however, the anther-cells, which morphologically correspond to the ovules, are in Coniferæ also borne on the lower side of the stamen-scale; and for further analogy we have to look to the *Cycadeæ*, and, be it boldly announced, to the *Ferns*. *Lycopodiaceæ*, on the other hand, bearing the spore-cases on the upper side of the leaf, cannot be regarded as the progenitors of Coniferæ, as has been thought. The relationship of Coniferæ is with *Cycadeæ* and Ferns, while *Gnetaceæ* become still farther removed from them. The writer of this notice has seen monstrous (proliferous) cones of *Abies Engelmanni*, in Colorado, but only at the upper limit of tree-vegetation, under similar conditions to the European monstrosities. He has also noticed the foliaceous development of the carpellary scales in monstrosities of *Abies Canadensis*, either into a distinct or a more or less connate pair of leaves; but only at the base, not, as in other species, at the top of the cone. G. L.

9. *Species, Genera, et Ordines Algarum. Volumen Tertium: De Floridеis Curæ Posteriores.* Auctore J. G. AGARDH. Lund. 1876.—In the present volume, the author reviews the species described in the first, second, and a portion of the third part of volume second of his classic work on algæ, giving frequent emendations, and interpolating the species described since the publication of that volume. The whole forms a volume of 700 pages, and, with the exception of the *Rhodomeleæ* and *Corallineæ*, purports to be a complete monograph of the orders of *Florideæ*. In the execution of the volume, the author has followed the same plan as in the preceding, and the text shows a careful editing, being comparatively free from typographical errors. Twenty species and two genera are either new to the United States or, for the first time, fully described. *Centroceras Oregonense* Ag., seems to be *Centroceras Eatonianum* Farlow, published in the Proc. Am. Acad., March 9, 1875. In the case of some of the species described from California, considering the small amount of material probably at his disposal, Agardh has been, perhaps, a little injudicious in separating as distinct species some forms which had been supposed to be identical with European species, as, for instance, *Sarcophyllis* (*Schizymenia*) *edulis*, taken to be the same as *S. edulis*, of Europe, and *Gymnogongyrus leptophyllus*, supposed to be *G. Griffithsiæ*. It is a well-known fact that species of algæ attain a larger size on the Californian coast than on European shores, and, in estimating whether a species is new, regard should be had to the difference of aspect produced by a more luxuriant growth. *Plocanium coccineum* illustrates this. In a collection of specimens of that species from all parts of the world, any experienced hand could readily pick out the specimens coming from California. Yet, although more luxuriant, no algologist, with the

exception of Kützing, would separate the Californian form as a distinct species. Should the Californian species of Agardh be accepted as genuine, it would go far to overturn the conclusion that, as in the case of phanerogams, so we have a number of species of algæ common to Europe and California, but wanting on the eastern coast of America. The significance of this view is familiar to the readers of this Journal from the writings of Professor Gray. The present volume, except for the preface and occasional footnotes, might be called a worthy sequel to those which have preceded. But in the preface, Agardh not only denies the fertilizing action of the antherozoids of the *Florideæ*, but even declares that he has not been able to see in the trichogyne anything more than an aborted branch. He completely ignores the brilliant discovery of Thuret and Bornet, and seems to think that the bare announcement that he does not believe it, ought to counterbalance the statements of careful observers. It may be that the neatly dried specimens on the herbarium shelves at Lund do not show clearly the nature of the trichogyne, but the correctness of Thuret's and Bornet's observations have been confirmed by numbers of algologists on the sea shore, and the fertilization of the more simple genera such as *Neuralion*, *Batrachospermum*, *Callithamnion*, etc., has become a common object of class-demonstration in the laboratories of Europe, and at least of one in this country. W. G. F.

10. *Notes Algologiques.* Fascicule I. Par M. M. Ed. Bornet et G. Thuret. Paris, 1876. Small folio.—This is the first portion of a work intended to embody the results of the observations of the late M. Thuret and Dr. Bornet for a long series of years. M. Thuret, during his frequent algological excursions, had a number of elaborate drawings executed, principally by Riocreux, with the intention of publishing them; but, owing to the difficulty of procuring capable engravers, the plan was abandoned. Not, however, wholly relinquishing his plan, he had many less complicated drawings prepared, which, on his untimely death in the spring of 1875, were bequeathed to his friend and co-worker, Dr. Bornet, who was to superintend their publication. The plates of this fascicule are twenty-five in number and, in point of execution, are unequalled by any relating to algæ, excepting those which illustrated Thuret's articles on zoöspores and antheridia in the *Annales*. The work is to algology what the *Carpologia Fungorum Selecta* of the Tulasne Brothers is to fungology. The text is no less rich and complete than the plates. A general description of the reproduction and reproductive organs of different genera precedes the detailed description of the plates, which, in the present fascicule, represent species referred to by Bornet in his *Deuxième Note sur les Gonidies des Lichens*, or which were collected by Schousboe in Morocco and determined by Thuret. The notes are a masterly exposition of the reproduction in the *Nostochineæ* and *Florideæ*, and are so replete with facts that a single reading barely suffices to give a general notion of the contents. Particularly interesting are the description of the reproduction of *Calothrix confervicola*,

and the comparative description of the fruit of the different genera included by older writers under *Callithamnion*. The fertilization of *Polyides*, similar to *Dudresnaya*, is referred to, but will probably be figured later. The work of Agardh is an encyclopædia in which one may find the name of any *Floridiæ* more easily perhaps than in any other. The work of Bornet and Thuret has a different object. Determination of names by a somewhat artificial grouping is subordinated to a true knowledge of the relations of algæ through a study of their minute anatomy and development.

W. G. F.

11. *Nuttall Ornithological Club.*—Bulletin No. 3, for September, contains, besides various miscellaneous notes, a paper by J. A. Allen on the Decrease of Birds in Massachusetts, one by Dr. Elliott Coues on the number of Primaries in Oscines, and one by William Brewster on the Yellow-bellied Woodpecker, *Sphyrapicus varius*.

12. *A Course of Practical Instruction in Elementary Biology*, by T. H. Huxley and H. N. Martin. Second edition, revised. 280 pp. 8vo. London and New York. 1876. (Macmillan & Co.)

13. *On Casting the skin in Menopoma Alleghaniense;* by A. R. Grote. The following observation has been recently made by Mr. Grote on a specimen in the aquarium of the Buffalo Society of Natural Sciences. The wide mouth is opened several times to its fullest extent, by which means the skin is parted on the lips, and then rolls backward over the head. Before this, the transparent pellicle was observed to be loosely surrounding the surface of the animal from which it had separated. By short jerky movements the *Menopoma* then withdrew its front legs from the old skin. The animal next moved in a forward direction, withdrawing itself from the skin, which was shoved back by the water until the skin was folded against the hind legs. The *Menopoma* then turned shortly round on itself, and, taking the skin in its mouth, drew it over the hind legs and tail. The skin was retained in the mouth and subsequently swallowed. The whole operation was quickly performed.

IV. Astronomy.

1. *Intra-Mercurial Planet.*—In his discussion of the theory of Mercury, Mr. Le Verrier found reason to believe in the existence of a planet, or of matter enough to form a planet, revolving around the sun within the orbit of Mercury. An observation of Mr. Weber, of Peckeloh, of a black round spot seen by him last April upon the sun, has revived the question, though Weber is proved, by observations at Madrid and Greenwich, to have seen only an ordinary sun-spot.

From nearly thirty observations within the last 115 years of spots supposed to have been such a planet, Mr. Le Verrier selects ten as most worthy of confidence, because the spot is reported to have been in motion. Of these, five are in March and October,

and they are fairly represented by a planet revolving in an orbit either in 33·02 or in 27·96 days; less exactly by an orbit of 24·25 days, or one of 40·32 days.

At Mr. Le Verrier's request the sun was observed early in October, both in this country and in Europe, but without result. He thinks a transit possible on the 22d of March next, if the orbit is one of 33·02 days. No other spring transit occurs with that supposition before 1885. For an October transit we must wait till about 1881. None of the observations made use of by Le Verrier, however, appear to be so free from doubts as to establish the existence of a planet within the orbit of Mercury. H. A. N.

2. *November Meteors.*—On the morning of November 14th, between twelve and one o'clock, the sky at New Haven was partly clear. Out of about twelve meteors seen, three might be called conformable to the radiant in Leo. Shortly after one o'clock the sky became wholly overcast. H. A. N.

IV. Miscellaneous Scientific Intelligence.

1. *On the Extirpation of Species;* by Prof. Alfred Newton. (From his Address, Brit. Assoc., as published in Nature of Sept. 14.)—And now to follow out the idea with which I began. Having touched on the two chief zoological events of the year, let us see if they do not suggest something that will not be beneath your consideration for the remainder of this address. I have spoken of the certainty of the expedition from which we now welcome our friends being succeeded by others of similar character. We shall hardly be indulging any vain imagination if we ask ourselves what we may look forward to as regards their reports; and to one point we may perhaps usefully apply ourselves.

What if a future *Challenger* shall report of some island, now known to possess a rich and varied animal population, that its present fauna had disappeared? that its only mammals were feral pigs, goats, rats, and rabbits—with an infusion of ferrets, introduced by a zealous "acclimatizer" to check the seperabundance of the rodents last-named, but contented themselves with the colonists' chickens? that sparrows and starlings, brought from Europe, were its only land-birds, that the former had propagated to such an extent that the cultivation of cereals had ceased to pay—the prohibition of bird-keeping boys by the local school-board contributing to the same effect—and that the latter (the starlings) having put an end to the indigenous insectivorous birds by consuming their food, had turned their attention to the settlers' orchards, so that a crop of fruit was only to be looked for about once in five years—when the great periodical cyclones had reduced the number of the depredators? that the goats had destroyed one half of the original flora, and the rabbits the rest? that the pigs devastated the potato-gardens, and yam-grounds? This is no fanciful picture. I pretend not to the gift of prophecy; that is a faculty alien to the scientific mind; but if we may reason from the

known to the unknown, from what has been and from what is to what will be, I cannot entertain a doubt that these things are coming to pass; for I am sure there are places where what is very like them has already happened.

You may ask why this is so? why do these lands so speedily succumb to the strangers from beyond the sea? One part of the answer is ready to hand with those who have learned one of the first principles of biology which our great master, Mr. Darwin, has laid down for us. The weaker, the more generalized forms of life must always make way for the stronger and more specialized. The other part of the answer is supplied by Mr. Wallace; for no one can have studied his volumes to much purpose without perceiving that the inhabitants of oceanic islands and of the southern hemisphere—the great Australian Region especially, and South America not much less, are the direct and comparatively speaking little-changed descendants of an older, a more generalized and a weaker fauna than are the present inhabitants of this quarter of the globe, which have been, so to speak, elaborated by nature and turned out as the latest and most perfect samples of her handiwork.

Set face to face with unlooked-for invaders, and forced into a contest with them from which there is no retreat, it is not in the least surprising that the natives should succumb. They have hitherto had to struggle for existence only with creatures of a like organization; and the issue of the contest which has been going on for ages is that, adapted to the condition under which they find themselves, they maintain their footing on the grounds of equality among one another, and so for centuries they may have "kept the noiseless tenor of their way." Suddenly man interferes and lets loose upon them an entirely new race of animals, which act and react in a thousand different fashions on their circumstances. It is not necessary that the new comers should be predacious; they may be so far void of offence as to abstain from assaulting the aboriginal population; but they occupy the same haunts and consume the same food. The fruit, the herbage, and other supplies that sufficed to support the ancient fauna now have to furnish forage for the invaders as well. Their effects on the flora there is no need for me to trace, since Dr. Hooker expressly made them one of the themes of that discourse to which many of us listened with rapt attention a few years since at this Association. But the consequences of the invasion to the native fauna have never been so fully made known. The new comers are creatures whose organization has been prepared by and for combat throughout generations innumerable. Their ancestors have been elevated in the scale of being by the discipline of strife. Their descendants inherit the developed qualities that enabled those ancestors to win a hard-fought existence when the animals around them were no higher in grade than those among which the descendants are now thrown. Can we doubt that the victory inclines to the heirs of the ancient conquerors? The struggle is like one between an army of veterans

and a population unused to warfare. It is that of Spaniards with matchlocks and coats of mail against Aztecs with feather cloaks and bows and arrows. *Mala salus victis.* A few years, and the majority of native species are exterminated. But this is not the worst. The species which perish most quickly are just those that naturalists would most wish to preserve; for they are those peculiar and endemic forms that in structure and constitution represent the ancient state of things upon the earth, and supply us with some of the most instructive evidence as to the order of nature.

With the progress of civilization it is plain that there will soon be hardly a land but will bear the standard of a European nation or of a community of European descent, and, as things are going on, be overrun by their imports. If this were inevitable, it would be useless to complain. But is it inevitable? Is it not obvious that most of this extermination is being carried on unwittingly, and may not some of it be avoided by proper precautions? If so, should not men of science make a stand, and interest the ignorant or careless in the importance of the subject? I cannot divest myself of the belief that the course of the next century will see the extirpation, not only of most of the peculiar faunas I had in view a few minutes ago, but of a great multitude of other species of animals throughout all parts of the world. The regret with which I regard such extirpation is not merely a matter of sentiment. Here sentiment and science are for once on the same side. A heavy blow will be inflicted on zoology by the disappearance of some of these marvellous and peculiar forms. There is no one species of animal whose structure and habits have been so completely investigated that absence of the means of further examination would not be a distinct deprivation to science; and as what Science has done is only an earnest of what she will do, we cannot say that the time shall ever come when the want of those means will not be severely felt. It is then for scientific men, and for naturalists especially, to consider whether they are not bound, in the interest of their successors, to interpose more than they have hitherto given any signs of doing.

But outside this audience there are many who care little for consequences like these. Such persons may, however, be impressed by thinking that the indiscriminate destruction of animals which, in one way or another, is now going on, must sooner or later lead to the extirpation of many of those which minister to our wants, whether of comfort or luxury. The fur-bearing creatures will speedily, if they do not already, require some protection to be generally accorded to them; and that such protection can be effectually given is evident if we take the trouble of inquiring as to the steps taken by the Russian local authorities in Alaska, and now, I believe, continued by those of the United States, for limiting the slaughter of the sea-otter and the fur-seals of the adjacent islands to particular seasons. No one can suppose that, even with the assistance we get from Siberia, our supply of ivory will con-

tinue what it now is when the interior of Africa is pacified and settled, as we can hardly doubt that it one day will be; and unless we can find some substitute for that useful substance before that day comes, it would be only prudent to do something to check the wasteful destruction of elephants. Many people may think that the continent of Africa is too vast, and its animal life too luxuriant, for the efforts of man materially to affect it. If we inquire, however, we shall find that this is not the case, and that there is an enormous tract of country, extending far beyond our colonies and the territories of the neighboring republics, from which most of the larger mammals have already disappeared. There is good reason to believe that at least one species has become extinct within the last five-and-twenty years or thereabouts; and though I do not mean to say that this species, the true zebra, had any economic value, yet its fate is an indication of what will befall its fellows; while to the zoologist its extirpation is a matter of moment, being probably the first case of the total extinction of a large terrestrial mammal since the remote days when the *Megaceros hibernicus* disappeared.

Time would fail me if I attempted to go into particulars with regard to the marine *Mammalia*. It is notorious that various members of the orders *Sirenia*, *Cetacea*, and *Pinnipedia*, have recently dwindled in numbers or altogether vanished from the earth. The manatee and dugong have been recklessly killed off from hundreds of localities where but a century or so since they abounded; and with them the stores of valuable oil that they furnish have been lost. That very remarkable Sirenian, the huge *Rhytina gigas* has become utterly extinct. The greed of whalers is believed to have had the same effect on a Cetacean (the *Balæna biscayensis*) which was once the cause of a flourishing industry on the coasts of France and Spain. The same greed has almost exterminated the right-whale of the northern seas, and is fast accomplishing the same end in the case of seals all over the world. You are probably aware that an Act of Parliament, passed in the session of 1875, was intended to put some check upon those bloody massacres that anually take place on the floating ice of the North Atlantic, to which these creatures resort at the time of bringing forth their young, when

"Sires, mothers, children in one carnage lie."

But, whether through official indifference, or what, I know not, the treaties with foreign nations authorized by that Act were not completed; and last spring, at the solicitation of certain Aberdeen or Peterhead shipowners, the Board of Trade allowed "one year more" of wholesale slaughter. Whatever other nations might like to do, our hands at least should have been unstained. It is admitted that in certain manufactures—that of jute, for instance—animal oil is absolutely necessary. It is easy to see that before long there will be very little animal oil forthcoming.

2. *List of papers read at the session of the National Academy of Sciences held at Philadelphia, Pa., October 17th, 18th, and 19th*, 1876.—

Contributions to Meteorology, by ELIAS LOOMIS.

Upon the direct comparison of Solar radiation with that of the Bessemer Furnace, and upon the law of Dulong and Petit, by S. P. LANGLEY.

On the affinities of Hypocephalus, by J. L. LECONTE.

On a change in the relative length of the British Bronze and Iron Standard Yards in the U. S. Office of Weights and Measures, by J. E. HILGARD.

On sound in relation to Fog Signals, by JOSEPH HENRY.

The Results of an Investigation upon the Transformations of Planorbis multiformis, by ALPHEUS HYATT.

On the transmission of the shock of the explosion at Hell Gate, by H. L. ABBOT.

On the geological structure and topographical aspects of the Catskill Mountains, by JAMES HALL.

On the physical structure and altitudes of the Southern groups of the Catskill Mountains, by A. GUYOT.

On the force involved in Crookes' Radiometer, by O. N. ROOD.

On a new method of studying the reflexion of sound waves, by O. N. ROOD.

On a property of the Retina first observed by Tait, by O. N. ROOD.

On a series of molecular changes in the basaltic rocks of Lake Superior, by R. PUMPELLY.

On the power of certain substances to abstract salts from their solution in water by filtration through them, by R. E. ROGERS.

Note on the new compensation of a pendulum heretofore described, by J. LAWRENCE SMITH.

The following is a list of the members elected at this session: G. F. Barker, Philadelphia, Pa.; Joel Asaph Allen, Cambridge, Mass.; William M. Gabb, Philadelphia, Pa.; E. S. Morse, Salem, Mass.; John Newton, U. S. Army.

3. *Proceedings of the Cincinnati Society of Natural History.*—No. 1 of these Proceedings, "January, 1876," has been recently published. Its twelve pages are occupied by a valuable paper on the Variation in form of the Family Strepomatidæ, with descriptions of new species, by A. G. Wetherby, which is illustrated by a plate of fifteen figures representing the new species, *Lithasia plicata*, *Angitrema parva*, *Goniobasis plicato-striata*, *Anculosa umbilicata*, *Angitrema angulata*.

4. *The Scientific Monthly, a Magazine devoted to the Natural Sciences.* E. H. FITCH, editor and proprietor, Toledo, Ohio.—The August number of this monthly, No. 11 of the first volume, contains various papers of popular interest. The first, by Dr. T. A. Fitch, continues an article on Springs, which is illustrated by a plate giving a view of a mud volcano.

5. *The Universal Metric System*, by ANDREW COLIN, M. E., Principal of a Preparatory Scientific School. 50 pp. 12mo. New York, 1876. (D. Appleton & Co.)—This little work was prepared, as the author states, "especially for candidates for schools of science, engineers and others;" and it is well adapted for its purpose, and for the wider one of fitting all students of the higher schools or academies of the country for the easy use of the metric system in calculations. The expression universal is applied to the system because, although first adopted by the French, "almost all the nations of the world have now adopted it," and its use will undoubtedly be soon actually universal. The explanations of the subject are simple and precise; and numerous problems are given, occupying eighteen pages, in order to make the work a good class-book.

6. *Bulletin of the Minnesota Academy of Natural Sciences, for the year* 1875. 44 pp. 8vo.—This Bulletin contains a paper by Prof. N. H. WINCHELL on early explorers of the Minnesota valley (continued); a report on Ornithology by Dr. F. L. HATCH; notes on Entomology, by R. J. MENDENHALL, treating of some noxious insects; notes on a storm on the 18th of July, 1867, over Pope and Douglass counties, Minnesota, by G. B. WRIGHT, the rainfall of which, in Sauk Centre, amounted to at least "30 inches and probably reached 36 inches;" meteorological statistics, by WILLIAM CHENEY; and notes on a deep well drilled at East Minneapolis; by N. H. WINCHELL. The depth of this well was 1421 feet, and it descended, after passing the surface soil, through the Trenton limestone and subjacent strata, to a clayey sandstone of the Primordial—the formation that affords the well known "pipestone" or *catlinite*, of Minnesota.

7. *Arrangements for a Meeting of the British Association—an example worth following.*—When the British Association met at Belfast (we cite from the Athenæum for Sept. 9), an excellent guide-book was prepared for the occasion and presented to members of Committees. In 1875, the promoters of the Bristol meeting, following up the experiment, brought out a larger and more elaborate hand-book. This year, at Glasgow, the scheme was further extended, and on Wednesday morning the members were surprised by the issue of a work in three volumes, one describing the geology of the district, another its fauna and flora, and the third its manufactures. Moreover several scientific collections were specially got up in view of the meeting, and nearly a hundred factories were thrown open for inspection. Besides, there were popular evening lectures outside of the work of the Association: on Monday evening, by Sir Wyville Thomson on the Challenger Expedition, on Tuesday evening, by Commander Cameron on his African explorations, and Saturday evening, by the same, to the workingmen of Glasgow. In addition, the excursions while of various kinds, were mainly for scientific purposes.

The following works were received too late to be here noticed:

Reports on the Geological Survey of Pennsylvania, by J. J. Stevenson and Professor Frazer, Jr.

Zoology of Lieut. Wheeler's Expedition. 1020 pp. 4to. with many plates, part of them colored.

The American Bisons, living and extinct, by J. A. Allen. 246 pp. 4to, with 12 plates. Memoirs of the Mus. Compar. Zool., Cambridge, Mass.

Monograph of American Trilobites, Part I; by A. Vogdes, U. S. A. 16 pp. Tampa, Florida. 1876.

OBITUARY.

CHARLES SAINTE-CLAIRE DEVILLE, the distinguished geologist and meteorologist, died on the 10th of October, aged 62 years. He was, at the time of his death, Inspector-General of the French Meteorological Stations. A notice in *Nature*, speaks of his singular modesty, and states that "in accordance with a desire expressed in his will, no official deputation of the Academy was present at his funeral, and no funeral oration was pronounced over his grave."

APPENDIX.

ART. L.—*Principal Characters of American Pterodactyls;** by Professor O. C. MARSH.

THE remains of *Pterosauria*, or flying lizards, hitherto found in this country, are all from the Upper Cretaceous deposits of Kansas. They are remarkable for their large size, some having a spread of wings not less than twenty-five feet. They differ widely from the Pterodactyls of the old world, especially in the *absence of teeth*, and hence have been placed by the writer in a new order, *Pteranodontia*,† from the typical genus *Pteranodon*.

In this genus, the skull is much elongated. The orbits, and the antorbital and nasal apertures are large. The maxillary and premaxillary bones are coossified, and entirely edentulous. The atlas and axis are united. The scapular arch presents some peculiar features, not before known in any vertebrate. The scapula, which is firmly coossified with the coracoid, has at its distal end an oblique articular face. This articulation is separated from the corresponding facet of the opposite scapula by a thin median plate, which is apparently a neural spine of a dorsal vertebra. The two scapulæ thus brace each other, and aid in securing powerful flight. In *Pteranodon* the fourth finger is greatly elongated, and the wing metacarpal is longer than half the antebrachium, There are five separate carpal bones, beside the pteroid bone which supported the membrane. The pteroid is not a true carpal, but is perhaps homologous with the small bone in the foot of a bat which supports the patagium. The first three metacarpals are very slender, pointed above, and do not reach the carpus. At their distal end they supported sharp, curved claws. In some species, the distal phalanx of the wing finger is not straight, but falciform.

The pelvis in *Pteranodon* is of moderate size. The ilia are elongate, and the acetabulum is imperforate. The ischia are broad, and united on the median line. The tail is short and slender, and the distal caudals are sometimes coossified. The posterior limbs are well developed. The tibia has at its distal end a pulley-like articular surface. There are two tarsal bones of

* Abstract of a paper read before the American Association for the Advancement of Science, at Buffalo, Aug. 28th, 1876.

† This Journal, vol. xi, p. 507, June, 1876.

nearly equal size, and a small lateral bone, which may possibly be the distal end of the fibula. There are four metatarsals of nearly the same length, and their ungual phalanges are pointed, but not much curved.

The known species of *Pteranodon* are as follows: *Pteranodon occidentalis* Marsh (*Ornithochirus harpyia* Cope), *Pteranodon ingens* Marsh (*Ornithochirus umbrosus* Cope), *Pteranodon velox* Marsh, *Pteranodon longiceps* Marsh, and *Pteranodon comptus* Marsh.

Nyctosaurus, gen. nov.

A second genus of American Pterodactyls is represented in the Yale Museum by several well preserved specimens. This genus is nearly related to *Pteranodon*, but may be readily distinguished from it by the scapular arch, in which the coracoid is not coossified with the scapula The latter bone, moreover, has no articulation at its distal end, which is comparatively thin and expanded. The type of this genus is *Pteranodon gracilis* Marsh, which may now be called *Nyctosaurus gracilis*. It was a Pterodactyl of medium size, measuring about eight to ten feet between the tips of the expanded wings. Its locality is in the upper Cretaceous of Western Kansas. The type specimens of all the above species are preserved in the Museum of Yale College.

INDEX TO VOLUME XII.*

A

Abbe, C., meteorological notice, 399.
Abert, S. T., survey in North Carolina, etc., 149.
Academy, National, Oct. meeting, 476.
Acids, synthesis of polybasic, 294.
Acoustics, researches in, *Mayer*, 329.
Agardh, J. G., work on algæ, 470.
Allantoin, synthesis of, 215.
Allen, J. A., variation in mammals, 238.
Amidines of monobasic acids, 54.
Ammonium nitrate, decomposition by heat, 52.
Andrews, E. B., erosion of rocks, 304.
Angles, glass circle for measuring, *Rutherfurd*, 112.
Annaheim, size of atoms, 451.
Anthony, W. A., electro-magnetic machine, 251.
Anthraflavic acids, 51.
Appalachia, noticed, 163.
Aricine, alkaloid, 139.
Armsby, H. P., reaction of sulphuric acid upon tri-calcic phosphate, 46.
Arthur, G. C., Flora of Iowa, 156.
Asparagin and saccharimetry, 139.
Association, American, Buffalo, 163, 316.
  Proceedings, 397.
Association, British, at Belfast, 478.
Artesian borings in Indiana, 460.
Atoms, size of, 451.
  shifting of, 293.
Attfield, J., Chemistry, 454.
Austen, P. T., dinitrobrombenzols, 118.
  dinitroaniline and dinitrobrombenzol, 121.

B

Baillon, Dictionnaire Botanique, 468.
Baird, S. F., Record of Science, 80.
Barker, G. F., chemical abstracts, 50, 138, 212, 292, 385, 451.
Barrett, S. T., Dalmanites dentatus, 70.
Bathybius, Challenger Exped. observations, 267.
Beal, J. W., products of Michigan, 156.
  sensitive stigmas, 308.
  botanical papers, noticed, 398.
Bentham and Hooker, Genera Plantarum, 77.
Benzene derivatives, composition of, 387.
  in rosin oil, 386.
Buckley, S. B., Geological Report, 63.
Blake, J., roscoelite, 31.
Blanford, H. T., coal eras of India, 67.
Bernstein, J., Senses of Man, 316.
Bernthsen, amidines of monobasic acids, 54.
Berthelot, decomposition of ammonium nitrate by heat, 52.
  formation of ozone, 212.
  absorption of nitrogen, 292.
  pyrogenic hydrocarbons in coal gas, 385.
Bill, J. H., decomposition of potassic bromide and sodic chloride, 190.
Blytt, A., immigration of Norwegian flora, 76.
Boisbaudran, gallium, 52, 452.
Boissier, E., Flora Orientalis, 468.
Bornet, E., G. A. Thuret, 155.
Bornet and Thuret, on Algæ, 471.
Botany—
  Algæ, works on, noticed, 470, 471.
  Asclepiad, juice of, 54.
  California, 78.
  Colorado flora, 234.
  Coniferæ, carpellary scales of, 469.
  Diatoms in straw, 232. 400.
  Dionæa, leaves of, 232.
  Epigæa, heteromorphism in, 74.
  Fertilization by insects, 397.
    and sensitive stigmas, 308.
  Flora, immigration of, 76.
  Grass, intoxicating, 233.
  Leafing, time of, and age of trees, 233.
  Leaves, inequilateral and venation of odd, 398.
  Oaks of United States, 153.
  Orange and olive, disease of, *Farlow*, 37.
  Periodicity of vegetation, 398.
  Scirpus, flowers in, 467.
  Tree-planting, 73.
  Utricularia vulgaris, 398.
Bourbonne-les-Bains minerals, 150.
Bradley, F. H., geological chart of United States, 286.
Brandegee, T. S., Flora of Colorado, 234.
Brewer, W. H., Botany of California, 78.
Bromide, decomposition of potassic, 190.
Brooks, T. B., Huronian south of Lake Superior, 194.
Browning, J., new magnifier, 57.

* The Index contains the general heads Botany, Geology, Mineralogy, Zoology, and under each the titles of Articles referring thereto are collected.

Burnham, S. W., catalogue of double stars, 204.
Butlerow, juice of Asclepiad, 54.
Burton, B. S., meteorite from North Carolina, 439.

C

Cailletet, high-pressure manometer, 215.
Canada, meteorology of, 399.
Carbonic acid in animal fluids, 388.
Carpenter, W. B., oceanic circulation, 159.
Caruel, T., Botanical Journal, 468.
Caspian and Black Seas, 162.
Cave, Robin Hood, 223.
Centennial, men of science at, 161.
Cephalization, connection of with animal development, *Dana*, 245.
Cerium, metallic, 53.
Challenger Exped., on sea-bottom deposits, 255.
Champion and *Pellet*, asparagin and saccharimetry, 139.
Chaumont, theory of ventilation, 241.
Chlorides, decomposition of sodic, *Bill*, 190.
Chlorine or bromine, substitution of, 214.
Chwolson, magnetic induction, 296.
Chlorates, action of galvanic current on, 293.
Cincinnati Soc. Nat. Hist., Proc., 477.
Clark, A. B., Compositæ Indicæ, 397.
Clark, F. W., Constants of Nature, 296.
Cleve, sulphonaphthalide, 51.
Columbium and tantalum compounds, 213.
Colin, A., Metric system, 477.
Colloids, freezing, 294.
Color theory, Vogel's, *Lea*, 48.
Comstock, T. B., discoveries of Brazilian Geological Commission, 464.
Utricularia, 398.
Connecticut Academy, Transactions, 80.
Cope, E. D., Eocene fauna of New Mexico, 297.
gigantic bird from Eocene, 306.
theory of evolution, 309.
List of Batrachia and Reptilia, 71.
Coues, E., Birds of Kerguelen Island, 72, 239.
Cox, E. T., Geological Report, 307, 460.
Crépin, Monographiæ Rosarum, 233.
Croll, J., tidal retardation and age of earth, 457.
Crosby, W. O., geological map of Massachusetts, 459.
Curves, Lissajous', 455.

D

Dale, T. N., Rhætic Strata, 223.
Damoiseau, substitution of chlorine for bromine, 214.
Dana, E. S., association of quartz and calcite in parallel position, 448.
mineralogical notices, 72, 151, 229, 395.
Dana, J. D., on the glacial flood, 64, 125.
note on erosion, 192.
cephalization, connection of, with animal development, 245.
Daubrée, on schistosity, 148.
Davenport Academy, Proceedings, 320.
Davidson, G., reclamation, 161.
Dawkins, W. B., Robin-Hood Cave, 223.
Dawson, J. W., Carboniferous Pulmonates, 226.
Carboniferous batrachians in Nova Scotia, 440.
De Candolle, C., leaves of Dionæa, 232.
Delesse, Révue de Géologie, 149.
Demole, shifting of atoms, 293.
Des Cloizeaux, chondrodite, 229.
Didymium, metallic, 53.
Dinitrobrombenzols, *Austen*, 118.
and dinitroaniline, *Austen*, 121.
Dœlter and Hœrnes, on dolomites, 72.
Domeyko, I., minerals of Peru, 395.
Dutton, C. E., earth's physical evolution, 142.

E

Earth, interior of, *Thomson*, 339.
age of, *Croll*, 457.
possibility of change of axis, *Thomson*, 350.
tidal retardation and age of, 457.
physical evolution of, 142.
Earthquakes, recent, *Rockwood*, 25.
Eccles, action of copper-zinc couple on chlorates and perchlorates, 293.
Eichler, A. G., Flora Brasiliensis, 156.
Electric convection, 390.
Electricity, velocity of, *Davidson*, 161.
Siemens, 295.
Electro-magnetic machine, *Anthony*, 251.
rotations, 58.
Electro-magnet, new, 57.
Engelmann, G., oaks of U. States, 153.
Engelmann, H., Geological Report, 221.
Environment, relation of living things to, *Wallace*, 357, 467.
Erlenmeyer, normal and iso-butyric acid, 138.
Erosion of valleys, *Gilbert*, 88; *Dana*, 92; *Andrews*, 304.
Ether, friction of, 217.
Ethyl sulphate, 50.
Evolution, theory of, *Cope*, 309.
on some points connected with, *Wallace*, 356.
connection of cephalization with, 245.

F

Farlow, W. G., disease of orange and olive trees, 37.
botanical notices, 470.
Films, liquid, 56.
Fire-damp, explosion of, 295.
Fitch, Scientific Monthly, 477.
Forel, waves on Lake Geneva, 212.
Foster, law of refraction, 56.
Frankland, nitrogen in waters, 292.
Fusion of soft bodies, 390.

G

Gallium, 52, 452.
Gas, coal, pyrogenic hydrocarbons in, 385.
Gases, friction of, 388, 390.
specific heat of, 217.
viscosity of, 140.
Geikie, A., geological map, noticed, 461.
Geinitz, F. E., mineral pseudomorphs, 231.
Genth, F. A., vanadium minerals, 32.
meteoric iron, 72.
Gentisin, 53.
Geological chart of United States, *Bradley*, 286, 461.
map of Europe, 151.
of Massachusetts, 459.
of Scotland, 461.
Geological Reports or Surveys—
Brazil, 227, 464.
Canada, 218.
Illinois, 227.
India, 462.
Indiana, 221, 307, 460.
Massachusetts, 459.
Michigan, 461.
New Brunswick, 218.
Newfoundland, 225.
New Mexico, 220.
New South Wales, 150.
Pennsylvania, 63.
Sumatra, 71.
Territories (Hayden's), 71, 145, 157, 219, 234.
Texas, 63.
Utah, 221.
Victoria, 149.
West of 100th Meridian (Wheeler's), 61.
Wisconsin, 71.
Geological reunion at Paris in 1878, 463.
Geology—
Ashley Beds, fossils from, 222.
Batrachians, Carboniferous, *Dawson*, 440.
Bird, Eocene, *Cope*, 306.
Brachiopods, Swedish, 227.
Carboniferous Pulmonates, *Dawson*, 226.
footprints in Indiana, 307.
Catskill Mt. range, *Hall*, 300.
Coal eras of India, 67.
Geology—
Coal-measure plants of Chili, 308.
Coal-measures, marine plants in, 221.
Colorado, ore-bearing rocks of, 71.
Colorado Plateau, *Gilbert*, 16, 85.
Corals, Tertiary, in Tasmania, 226.
Crinoid, new Cretaceous, *Grinnell*, 81.
Dalmanites dentatus, *Barrett*, 70.
Dolomites, origin of, 72.
Eocene fauna of N. Mexico, *Cope*, 297.
Eozoon, and serpentine, 147.
Eozoon limestones, 298.
Erosion, *Dana*, 192.
G. K. Gilbert, 88.
by spray, *Andrews*, 304.
Glacial era, 68.
flood, *Dana*, 64, 125.
in Great Britain, 65.
Permian or Triassic, 67.
striæ, 218.
Graptolites, 69.
Greenstones of New Hampshire, *Hawes*, 129, 395.
Hungary, eruptive rocks of, 69.
Huronian of Canada, *Selwyn*, 461.
south of Lake Superior, *Brooks*, 194.
Mammals, Tertiary, *Marsh*, 401.
Man and mammalia in Robin-Hood Cave, 223.
Man in Lower Pliocene, 147.
Marbles, Carrara, 147.
Mascarene of New Brunswick, 218.
Mesozoic red shales, fishes of, 223.
Metadiabase, see Greenstones.
Mexico, the Huasteca, *Kimball*, 277.
Mountain making, *Dutton*, 142.
Mountain structure, *Powell*, 414.
New Haven, drift deposits, *Dana*, 125.
New York, Southern, *Hall*, 300.
Oldhamia in Wisconsin, 226.
Primordial of Scandinavia, 64.
of Rocky Mts., 62.
Pterodactyls, *Marsh*, 479.
Rivers, detritus of, 462.
Schistosity, experiments on, 148.
Serpentine and Eozoon, 147.
Serpentine limestones of N. York, 298.
Silurian dioryte, etc., in Newfoundland, 225.
Spitzbergen, 65.
Theriodonts, Permian, *Owen*, 224.
Vertebrates of New Mexican Eocene, *Cope*, 297.
Volcanic phenomena of the Alps, 69.
Gilbert, G. K., Colorado Plateau, 16, 85.
Glaciers, streams beneath, 395.
see further under Geology.
Glycerine crystallized, 293.
Goode, G. B., Fishes of Bermudas, 239.
Gray, A., botanical notices, 73, 153, 232, 397, 467.

Gray, A., heteromorphism in Epigæa, 74.
coloration and environment, 467.
flowers in Scirpus, 467.
Darwiniana, noticed, 235.
Green, A. H., Physical Geology, 71.
Grimaux, synthesis of allantoin, 215.
Grinnell, G. B., new crinoid, 81.
Grote, A. R., note on Menopoma, 313, 472.
zoological notice, 157.
Grotrian, viscosity of salt-solutions, 140.
Guthrie, freezing colloids, 294.

H

Hall, J., serpentine limestones, 298.
geology of southern New York, 300.
Hanks, H. G., durangite, 274.
Harrington, B. J., analyses of minerals, 218.
Haughton, Lavas of Vesuvius, 227.
Hartt, C. F., geological discoveries, 464.
Hawes, G. W., greenstones of New Hampshire, 129, 395.
Hayden, publications of Expedition under, 71, 145, 157, 219, 234.
Heat, mechanical equivalent of, 455.
Heights of Lake Winnipeg and others, 218.
Helmholtz, electric convection, 390.
Hesse, alkaloid aricine, 139.
Hicks, W. M., friction of ether, 217.
Hillebrand and *Norton*, metallic cerium, lanthanum, didymium, 53.
Hill, H. B., ethers of uric acid, 428.
Hlasiwetz and *Habermann*, gentisin, 53.
Hofmeister, carbonic acid in animal fluids, 388.
Hooker, J. D., Flora of India, 397.
Houston, E. J., Physical Geography, 163.
Howe, A. B., gmelinite in Nova Scotia, 270.
Huxley and Martin, Biology, 472.
Huxley in New York, 399.
Hyatt, J., periodicity in vegetation, 398.
Hydrogen antimonide or stibine, 213.
Hydrogen, evolution of, 51.

I

Indian mounds, papers on, 320.
Isomerism, physical, 214.

J

Jeannel, sound and radiometer, 389.
Joly, columbium and tantalum, 213.
Jones, hydrogen antimonide or stibine, 213.
Jordan, D. S., Manual of Vertebrates, 315.
Rafinesque's Ichthyologia, 158.
Joule, equivalent of heat, 455.

K

Kansas Academy, Transactions, 163.
Kidder, J. H., Natural History of Kerguelen Is., 72, 239.
Kimball, A. S., changes in steel by tempering, 110
Kimball, J. P., grahamite in and geology of the Huasteca, 277.
Kœhler, A., Practical Botany, 234.
Kollmyer, A. H., Key to Chemistry, 454.
König, R., sounding of two notes, 141.
Knight, C., streams beneath glaciers, 395.
Kundt specific heat of gases, 217.
friction of gases, 390.

L

Lactic acid from inosite, 294.
Lanthanum, metallic, 53.
Lartet, Reliquiæ Aquitanicæ. 70.
Lavas of Vesuvius, 227.
Laubenheimer, physical isomerism, 214.
Lea, I., inclusions in gems, 151.
Lea, M. C., Vogel's color theory, 48.
Le Conte, J. L., Address, 314.
Leidy, J., fossils from Ashley beds, 222.
fishes of Mesozoic red shales, 223.
Leonhard, G., minerals of Baden, 230.
Lesley, J. P., Geological Report, 63.
Lesquereux, marine plants from coal-measures, 221.
Lightning, protection from, 457.
Liquids, analysis of mixed, 139.
Loomis, E., contributions to meteorology, 1.
Loven, S., Echinoidés, 239.
Lyman, T., Ophiuridæ, 158.

M

Macomb, J. N., explorations under, 220.
Magnetic induction, 296.
Magnifying glass, new, 57.
Mallard, explosion of fire-damp, 295.
Mallet's theory of volcanic energy, 463.
Malt extract, action on starch, 388.
Man in Lower Pliocene, 147.
Man, origin and antiquity of, *Wallace* 371.
Manganese of sea-bottom, 265.
Manometer, high pressure, 215.
Marsh, O. C., new Tertiary mammals, 401.
Characters of American Pterodactyls, 479.
recent discoveries by, 59.
Maxwell, Ohm's law, 455.
protection from lightning, 457.
Mayer, A. M., researches in acoustics, 329.
Mazurowska, ethyl sulphate, 50.
McCoy, Paleontology of Victoria, 149.
McCulloch, R. S., Theory of Heat, 241.
Meehan, insects and fertilization, 397.
Meek, F. B., Geological Report, 145, 221.
Mercadier, Lissajous' curves, 455.
Metadiabase, *Hawes*, 395.

Meteoric iron, Pittsburg, 72.
Smith, 107.
Meteoric stone, new, *Smith*, 207.
Meteorite, fall of, *Parker*, 316.
from North Carolina, *Burton*, 439.
Meteorites, gases in, 165.
Meteorology, contributions to, *Loomis*, 1.
Meteors, November, 1876, 473.
Meyer, L., evolution of hydrogen, 51.
Meyer, V., vapor-density, 453.
Miers, J., Barringtoniaceæ, 469.
Mineralogy, Journal of, 152.
MINERALS, ETC.—
Analcite not isometric, 151.
Aragonite on meteoric iron, *Smith*, 107.
Calcite, quartz and, *E. S. Dana*, 448.
Calcozincite, 231.
Chondrodite, 229.
Cuprocalcite, 396.
Daubréelite, *Smith*, 109.
Daubreite, 396.
Dolomite, 72.
Durangite, *Hanks*, 274.
Euchlorite, 231.
Franklinite and spinel group, *Seyms*, 210.
Friedelite, 151.
Gmelinite in Nova Scotia, *Howe*, 270.
Grahamite, *Kimball*, 277.
Huantajayite, 396.
Humite, 229.
Ihleite, 151.
Keatingine, 231.
Krönkite, 396.
Malinowskite, 397.
Mottramite, 466.
Onyx, Mexican, 466.
Pelhamite, 231.
Phillipite, 396.
Psittacinite, *Genth*, 35.
Quartz and calcite, *E. S. Dana*, 448.
Roscoelite, *Blake, Genth*, 31, 32; *Roscoe*, 466.
Tripoli, Carboniferous, in Indiana, 307.
Vanuxemite, 231.
Werthemanite, 396.
of Bourbonne-les-bains, 150.
Minnesota Academy, Bulletin, 478.
Müller, F. de, Phytographiæ Australiæ, 156.
Murray, J., sea-bottom, 255.
Museum, National, Bulletin, 71, 158, 239.

N

Naphthalene, 138.
Natural selection, mimicry, 311.
Wallace, 354.
Newberry, J. S., Geological Report, 220.
Newton, A., extirpation of species, 473.
Newton, H. A., astronomical notice, 472.
New York, geographical survey of, 162.
Nipher, F. E., probability of error in writing numbers, 79.
Nitrates, Schœnbein's test for, *Storer*, 176.
Nitrogen, absorption of, 292.
in potable waters, 292.
measuring tube, 452.

O

Obermayer, viscosity of gases, 140.
OBITUARY—
Argelander, F. W. A., 113.
Angelin, 80.
Billings, E., 80.
Davies, Charles, 320.
Deville, Charles Sainte-Claire, 478.
Ehrenberg, 244.
Newman, Edward, 244.
McCheeney, 244.
Poinier, Porter, 164.
Snell, Ebenezer, 320.
Ocean, depth between Britain and Greenland, 65.
bottom deposits of, Challenger Expedition, 255.
Oceanic circulation, *Carpenter*, 159.
Ohm's law, 455.
Orton, J., Comparative Zoology, 237.
Ost, synthesis of polybasic acids, 294.
O'Sullivan, malt extract on starch, 388.
Owen, R., Permian Theriodonts, 224.
Ozone, formation of, 212.

P

Packard, A. S., Geometrid Moths, 157.
Parker, J. D., fall of meteorite, 316.
Parkhurst, H. M., Astronomical tables, 79.
Pendulum, compensating, *Smith*, 106.
Peters, C. H. F., new variables and new planet, 210.
latest planets, 291.
Petersson and *Ekmann*, atomic weight of selenium, 451.
Pfaundler, fusion of soft bodies, 390.
Phosphate, reaction of sulphuric acid upon tri-calcic, *Armsby*, 46.
Phosphoric acid, glycero-, from brain, 453.
Pickering, C., Distribution of Plants and Animals, 320.
Pickering, E. C., physical abstracts, 56, 139, 215, 294, 388, 455.
Physical Manipulation, noticed, 240.
Planet, new, *Peters*, 210.
latest, *Peters*, 291.
intra-Mercurial, 472.
Polarization currents, 296.
Porter, J. W., Oldhamia in Wisconsin, 226.
Poughkeepsie Soc. Nat. Sci., Proc., 163.
Powell, J. W., orographic structure, 414.
Geology of Uinta Mts., 305.
Probability of error in writing numbers, *Nipher*, 79.

Putnam, F. W., Archæological Report, 243.

R

Radiometer, Crookes', *Rood.* 405.
effect of sound on, 389.
Refraction, law of, 56.
Richardson, R., Ice Age, 65.
Rio de Janeiro, Archivos do Museu, 239.
Rockwood, C. G., Jr., recent earthquakes 25.
Rominger, C., Fossil Corals, 461.
Rood, O. N., Crookes' radiometer, 405.
Roos, Van H., crystallized glycerin, 293.
Rowland, H. A., electromagnetic action of electric convection, 390.
Rutherfurd, L. M., glass circles for measuring angles, 112.

S

Sadebeck, A., Crystallography, 152.
Salt solutions, viscosity of, 140.
Sargent, C. S., tree-planting, 73.
Saussure, H. de, American Wasps, 158.
Schiller, polarization currents, 296.
Schunk and *Roemer*, anthraflavic and isoanthraflavic acids, 51.
Schützenberger, P., fermentation, 55.
Scudder, mimicry in butterflies, 311.
Sea, see OCEAN.
Selenium, atomic weight of, 451.
Selwyn, Huronian of Canada, 461.
Geological Report, noticed, 218.
Serrin, new electro-magnet, 57.
Seyms, G. H., franklinite and spinel group, 210.
Shepard, C. U., new minerals, 231.
Schrauf, new minerals, 151.
Siemens, analysis of mixed liquids, 139.
Siemens, W., velocity of electricity, 295.
Simpson, J. H., explorations under, 221.
Smith, J. L., compensating pendulum, 106.
aragonite and new mineral with meteoric iron, 107.
new meteoric stone, 207.
Smith, W., benzene in rosin oil, 386.
Solar, see SUN.
Sondhauss, liquid films, 56.
Sounding of two notes, simultaneous, 141.
Species, extirpation of, 473.
Spice, R., sympathetic resonance of tuning forks, 411.
Spottiswoode, W., electro-magnetic rotations, 58.
Stars, catalogue of double, *Burnham*, 204.
Steel, changes in, *Kimball*, 110.
Stibine, or hydrogen antimonide, 213.
Storer, F. H., Schœnbein's test for nitrates, 176.
Sulphonaphthalide, 51.
Sun, displacement of lines in spectrum of, *Young*, 321.
Sutton, F., Volumetric Analysis, 454.

T

Thomson, W., British Association Address, 336.
Thudicum and *Kengzett*, glycero-phosphoric acid from brain, 453.
Tuning forks, sympathetic resonance of, *Spice*, 411.
Tyndall, J., Sound, 459.

U

Uric acid, ethers of, 428.

V

Vapor-density, 453.
Variables, new, *Peters*. 210.
Vasey, G., Catalogue of trees, 469.
Ventilation, theory of, 241.
Verrill, A. E., gigantic cephalopods, 236.
zoological notices, 237, 315.
Vohl, lactic acid from inosite, 294.
Volcanic dust, shower of, 147.
Volcanic energy, 463.

W

Wallace, A. R., British Association Address, 354, 400, 467.
Waters, nitrogen in potable, 292.
Waves on Lake Geneva, 216.
Wheeler, G. M., Geological Report of Expedition under, 61.
Wiedemann, friction of gases, 388.
Wilder, brain of sharks and skates, 103.
Wilson, P. B., diatoms in straw, 232, 400.
Winchell and Harrington, Geological Report, 149.
Wreden, naphthalene, 138.
Wright, A. W., gases in meteorites, 165.
book notices, 240.
Wroblewsky, benzene derivatives, 387.
Wynne, Indian Geology, 462.

Y

Young, C. A., displacement of lines in solar spectrum, 321.

Z

ZOOLOGY—
Brain of sharks and skates, *Wilder*, 103.
Butterflies, mimicry in, *Scudder*, 311.
Cephalization, connection of with animal development, *Dana*, 245.
Cephalopods, gigantic, 236.
Corals, tabulate, 158.
Entomological Address, *Le Conte*, 314.
Environment, *Wallace*, 357, 400, 467.
Evolution, theory of, *Cope*, 309.
Kerguelen Island, 239.
Locust invasion of 1874, 156.
Menopoma, notes on, *Grote*, 313, 472.
Ornithological Club, Bulletin, 79, 472.
Species, extirpation of, 473.
See further under GEOLOGY.
Zulkowsky, nitrogen-measuring tube, 452.

Ad-
os-
of,

36.

Ad-

of

03.
00.
ical

65.

in

03.
1.
ani-

314.
67.

472.
472.

452.